S3 Appendix. Titmice key example

```
"$schema":
"https://raw.githubusercontent.com/WouterKoch/Clavis/main/Schema/Clavis.
   "title": "A key to titmice in Norway",
   "language": "en",
   "license": "https://creativecommons.org/licenses/by/4.0/",
  "creator": "person:wouterkoch",
   "lastModified": "2022-03-19 21:41:00",
   "identifier": "9be11d7e-c147-400a-899e-b3d5e4bcc6a1",
   "geography": {
      "name": "Norway",
      "polygon": [
         33.22265625,
                  69.56522590149099
               ],
                  29.267578125,
                  71.15939141681443
               ],
                  23.5546875,
                  71.28669893545877
               ],
                  17.2265625,
                  69.97549253616164
               ],
                  12.392578125,
                  68.366801093914
               ],
                  11.2939453125,
                  65.91062334197893
               ],
                  3.8671874999999996,
                  62.103882522897855
               ],
                  4.7021484375,
                  58.516651799363785
```

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```
],
            7.119140625,
               57.70414723434193
            ],
            [
               11.953125,
               58.83649009392136
            ],
            [
               13.3154296875,
               61.39671887310411
            ],
            12.8759765625,
               63.6267446447533
            ],
            14.94140625,
               64.07219957867282
            ],
            [
               15.2490234375,
               66.05371622067922
            ],
               18.852539062499996,
               68.02402198693447
            ],
               25.048828125,
               68.51214331858073
            ],
            26.894531249999996,
               69.54987728327795
            ],
            29.003906249999996,
               68.8159271333607
            ],
            [
               33.22265625,
               69.56522590149099
            ]
         ]
      ]
   ]
},
"persons": [
   {
      "id": "person:wouterkoch",
```

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```
"name": "Wouter Koch"
                                                                                 99
   }
                                                                                100
],
                                                                                101
"organizations": [
                                                                                102
                                                                                103
       "id": "organization:ntnu",
       "name": "Norwegian University of Science and Technology",
                                                                                105
       "url": "https://www.ntnu.no"
                                                                                107
],
                                                                                108
"externalServices": [
                                                                                109
       "id": "service:nbic_taxa",
                                                                                111
       "title": "NBIC taxonomy scientificNameId",
                                                                                112
       "provider": "Norwegian Biodiversity Information Centre",
                                                                                113
       "url": "https://www.artsdatabanken.no/help"
                                                                                114
   }
                                                                                115
],
                                                                                116
"taxa": [
                                                                                117
   {
                                                                                118
       "id": "taxon:paridae",
                                                                                119
       "scientificName": "Paridae",
                                                                                120
       "rank": "family",
       "vernacularName": "titmice",
                                                                                122
       "externalReference": {
          "serviceId": "service:nbic_taxa",
                                                                                124
          "externalId": "4362"
                                                                                125
       },
                                                                                126
       "children": [
          {
                                                                                128
             "id": "taxon:cyanistes",
              "scientificName": "Cyanistes",
                                                                                130
             "rank": "genus",
                                                                                131
             "externalReference": {
                                                                                132
                 "serviceId": "service:nbic_taxa",
                                                                                133
                 "externalId": "4364"
                                                                                134
             },
                                                                                135
             "children": [
                 {
                                                                                137
                    "id": "taxon:cyanistes_caeruleus",
                    "scientificName": "Cyanistes caeruleus",
                                                                                139
                    "vernacularName": "blue tit",
                    "rank": "species",
                                                                                141
                    "externalReference": {
                                                                                142
                        "serviceId": "service:nbic_taxa",
                                                                                143
                        "externalId": "4365"
                                                                                145
                 }
             ]
                                                                                147
          },
                                                                                148
          {
                                                                                149
             "id": "taxon:lophophanes",
                                                                                150
```

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```
"scientificName": "Lophophanes",
                                                                     151
"rank": "genus",
                                                                     152
"externalReference": {
                                                                     153
   "serviceId": "service:nbic_taxa",
                                                                     154
   "externalId": "4368"
                                                                     155
                                                                     156
"children": [
                                                                     157
   {
       "id": "taxon:lophophanes_cristatus",
                                                                     159
       "scientificName": "Lophophanes cristatus",
                                                                     160
       "vernacularName": "crested tit",
                                                                     161
       "rank": "species",
       "externalReference": {
                                                                     163
          "serviceId": "service:nbic_taxa",
                                                                     164
          "externalId": "4369"
                                                                     165
                                                                     166
       "geography": {
                                                                     167
          "polygon": [
                                                                     168
             [
                                                                     169
                 170
                     171
                        11.997070312499998,
                                                                     172
                        58.74540696858028
                    ],
                                                                     174
                     13.0517578125,
                                                                     176
                        59.977005492196
                                                                     177
                    ],
                                                                     178
                     Г
                                                                     179
                        12.8759765625,
                                                                     180
                        63.31268278043484
                                                                     181
                    ],
                                                                     182
                     183
                        19.2041015625,
                                                                     184
                        68.57644086491786
                                                                     185
                    ],
                                                                     186
                     Γ
                                                                     187
                        13.4912109375,
                        68.78414378041504
                                                                     189
                    ],
                                                                     190
                                                                     191
                        9.7119140625,
                        64.47279382008166
                                                                     193
                    ],
                                                                     194
                     Γ
                                                                     195
                        4.21875,
                        62.2679226294176
                                                                     197
                    ],
                                                                     199
                        3.69140625,
                                                                     200
                        59.40036514079251
                                                                     201
                    ],
                                                                     202
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},

```
Г
                         6.723632812499999,
                         57.70414723434193
                     ],
                      11.997070312499998,
                         58.74540696858028
                      ]
                   ]
               ]
            ]
         }
      }
   ]
},
   "id": "taxon:parus",
   "scientificName": "Parus",
   "rank": "genus",
   "externalReference": {
      "serviceId": "service:nbic_taxa",
      "externalId": "4363"
   },
   "children": [
      {
         "id": "taxon:parus_major",
         "scientificName": "Parus major",
         "vernacularName": "great tit",
         "rank": "species",
         "externalReference": {
             "serviceId": "service:nbic_taxa",
             "externalId": "4372"
         }
      }
   ]
},
{
   "id": "taxon:periparus",
   "scientificName": "Periparus",
   "rank": "genus",
   "externalReference": {
      "serviceId": "service:nbic_taxa",
      "externalId": "4374"
   },
   "children": [
      {
         "id": "taxon:periparus_ater",
         "scientificName": "Periparus ater",
         "vernacularName": "coal tit",
         "rank": "species",
         "externalReference": {
             "serviceId": "service:nbic_taxa",
```

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```
"externalId": "4375"
      }
   ]
},
{
   "id": "taxon:poecile",
   "scientificName": "Poecile",
   "rank": "genus",
   "externalReference": {
      "serviceId": "service:nbic_taxa",
      "externalId": "4378"
   },
   "children": [
      {
         "id": "taxon:poecile_palustris",
          "scientificName": "Poecile palustris",
         "vernacularName": "marsh tit",
         "rank": "species",
         "externalReference": {
             "serviceId": "service:nbic_taxa",
            "externalId": "4385"
         },
          "geography": {
             "polygon": [
               [
                   11.997070312499998,
                         58.74540696858028
                     ],
                         13.0517578125,
                         59.977005492196
                     ],
                      Γ
                         12.8759765625,
                         63.31268278043484
                     ],
                      [
                         19.2041015625,
                         68.57644086491786
                      ],
                         13.4912109375,
                         68.78414378041504
                      ],
                         9.7119140625,
                         64.47279382008166
                     ],
                      Г
```

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```
4.21875,
                                  62.2679226294176
                               ],
                               Γ
                                  3.69140625,
                                  59.40036514079251
                               ],
                               Γ
                                  6.723632812499999,
                                  57.70414723434193
                               ],
                               Г
                                  11.997070312499998,
                                  58.74540696858028
                               1
                            ]
                         ]
                     ]
                  }
               },
                   "id": "taxon:poecile_montanus",
                   "scientificName": "Poecile montanus",
                   "vernacularName": "willow tit",
                   "rank": "species",
                   "externalReference": {
                      "serviceId": "service:nbic_taxa",
                      "externalId": "4382"
                  }
               },
                   "id": "taxon:poecile_cinctus",
                   "scientificName": "Poecile cinctus",
                   "vernacularName": "Siberian tit",
                   "rank": "species",
                   "externalReference": {
                      "serviceId": "service:nbic_taxa",
                      "externalId": "4379"
               }
            ]
         }
   }
],
"characters": [
   {
      "id": "character:head_top",
      "title": "Top of the head",
      "states": [
         {
            "id": "state:black_or_dark_grey",
```

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```
"title": "Black or dark grey"
                                                                              359
      },
                                                                              360
                                                                              361
          "id": "state:blue",
          "title": "Blue"
                                                                              363
      },
                                                                              365
          "id": "state:speckled_crest",
          "title": "Speckled black and white, with a crest"
                                                                              367
                                                                              368
   ]
},
                                                                              371
   "id": "character:head_top",
   "title": "Top of the head",
                                                                              373
   "states": [
                                                                              374
       {
                                                                              375
          "id": "state:black_or_dark_grey",
                                                                              376
          "title": "Black or dark grey"
                                                                              377
      },
                                                                              378
                                                                              379
          "id": "state:brown",
                                                                              380
          "title": "Brown"
      },
                                                                              382
       {
          "id": "state:blue",
                                                                              384
          "title": "Blue"
      },
                                                                              386
          "id": "state:speckled_crest",
          "title": "Speckled black and white, with a crest"
                                                                              390
   ]
                                                                              391
},
                                                                              392
                                                                              393
   "id": "character:chest_color",
                                                                              394
   "title": "Color of the chest",
                                                                              395
   "states": [
                                                                              397
          "id": "state:yellow",
          "title": "Yellow"
                                                                              399
      },
                                                                              401
          "id": "state:grey_brown",
                                                                              402
          "title": "Grey to brown"
                                                                              403
      }
   1
                                                                              405
},
{
                                                                              407
   "id": "character:wing_bar",
   "title": "White bar on the wing",
                                                                              409
   "states": [
```

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```
411
             "id": "state:wing_bar",
                                                                                412
             "title": "Present"
                                                                                413
          },
                                                                                414
                                                                                415
             "id": "state:no_wing_bar",
                                                                                416
             "title": "Absent"
                                                                                417
          }
      ]
                                                                                419
   },
                                                                                420
                                                                                421
      "id": "character:black_of_cheek",
      "title": "Color of the cheek at the back",
                                                                                423
      "states": [
          {
                                                                                425
             "id": "state:white_cheek_back",
             "title": "Entire cheek white"
                                                                                427
          },
                                                                                428
          {
             "id": "state:brown_cheek_back",
                                                                                430
             "title": "Sullied brown"
                                                                                431
          }
                                                                                432
      ]
   },
                                                                                434
   {
      "id": "character:wing_secondaries_color",
                                                                                436
      "title": "Color of secondary wing feathers",
                                                                                437
      "states": [
                                                                                438
          {
             "id": "state:secondaries_pale",
                                                                                440
             "title": "Paler than rest of the wing"
         },
                                                                                442
          {
                                                                                443
             "id": "state:secondaries_not_pale",
             "title": "No clear different from rest of the wing"
                                                                                445
          }
                                                                                446
      ]
                                                                                447
   }
],
                                                                                449
"statements": [
                                                                                450
   {
                                                                                451
      "id": "statement:crested_tit_head",
      "taxon": "taxon:lophophanes_cristatus",
                                                                                453
      "character": "character:head_top",
      "value": "state:speckled_crest",
                                                                                455
      "frequency": 1
   },
                                                                                457
   {
      "id": "statement:blue_tit_head",
                                                                                459
      "taxon": "taxon:cyanistes_caeruleus",
      "character": "character:head_top",
                                                                                461
      "value": "state:blue",
                                                                                462
```

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```
"frequency": 1
                                                                            463
},
                                                                            464
{
                                                                            465
   "id": "statement:poecile_palustris_head",
   "taxon": "taxon:poecile_palustris",
                                                                            467
   "character": "character:head_top",
                                                                            468
   "value": "state:black_or_dark_grey",
                                                                            469
   "frequency": 1
},
                                                                            471
{
                                                                            472
   "id": "statement:poecile_montanus_head",
                                                                            473
   "taxon": "taxon:poecile_montanus",
   "character": "character:head_top",
                                                                            475
   "value": "state:black_or_dark_grey",
                                                                            476
   "frequency": 1
                                                                            477
},
                                                                            478
{
                                                                            479
   "id": "statement:poecile_cinctus_head",
                                                                            480
   "taxon": "taxon:poecile_cinctus",
                                                                            481
   "character": "character:head_top",
                                                                            482
   "value": "state:brown",
                                                                            483
   "frequency": 1
                                                                            484
},
{
                                                                            486
   "id": "statement:great_tit_head",
   "taxon": "taxon:parus_major",
                                                                            488
   "character": "character:head_top",
   "value": "state:black_or_dark_grey",
                                                                            490
   "frequency": 1
},
                                                                            492
{
   "id": "statement:coal_tit_head",
                                                                            494
   "taxon": "taxon:periparus_ater",
                                                                            495
   "character": "character:head_top",
   "value": "state:black_or_dark_grey",
                                                                            497
   "frequency": 1
                                                                            498
},
                                                                            499
{
   "id": "statement:crested_tit_chest",
                                                                            501
   "taxon": "taxon:lophophanes_cristatus",
                                                                            502
   "character": "character:chest_color",
                                                                            503
   "value": "state:grey_brown",
   "frequency": 1
                                                                            505
},
                                                                            506
{
                                                                            507
   "id": "statement:blue_tit_chest",
   "taxon": "taxon:cyanistes_caeruleus",
                                                                            509
   "character": "character:chest_color",
                                                                            510
   "value": "state:yellow",
                                                                            511
   "frequency": 1
                                                                            512
},
                                                                            513
{
```

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```
"id": "statement:poecile_chest",
                                                                            515
   "taxon": "taxon:poecile",
                                                                            516
   "character": "character:chest_color",
                                                                            517
   "value": "state:grey_brown",
                                                                            518
   "frequency": 1
                                                                            519
},
                                                                            520
{
                                                                            521
   "id": "statement:great_tit_chest",
   "taxon": "taxon:parus_major",
                                                                            523
   "character": "character:chest_color",
                                                                            524
   "value": "state:yellow",
                                                                            525
   "frequency": 1
},
                                                                            527
{
   "id": "statement:coal_tit_chest",
                                                                            529
   "taxon": "taxon:periparus_ater",
   "character": "character:chest_color",
                                                                            531
   "value": "state:grey_brown",
                                                                            532
   "frequency": 1
                                                                            533
},
                                                                            534
{
                                                                            535
   "id": "statement:crested_tit_bar",
                                                                            536
   "taxon": "taxon:lophophanes_cristatus",
   "character": "character:wing_bar",
                                                                            538
   "value": "state:no_wing_bar",
   "frequency": 1
                                                                            540
},
                                                                            542
   "id": "statement:blue_tit_bar",
   "taxon": "taxon:cyanistes_caeruleus",
                                                                            544
   "character": "character:wing_bar",
   "value": "state:wing_bar",
                                                                            546
   "frequency": 1
                                                                            547
},
                                                                            548
                                                                            549
   "id": "statement:poecile_bar",
                                                                            550
   "taxon": "taxon:poecile",
                                                                            551
   "character": "character:wing_bar",
   "value": "state:no_wing_bar",
                                                                            553
   "frequency": 1
                                                                            554
},
                                                                            555
{
   "id": "statement:great_tit_bar",
                                                                            557
   "taxon": "taxon:parus_major",
                                                                            558
   "character": "character:wing_bar",
                                                                            559
   "value": "state:wing_bar",
   "frequency": 1
                                                                            561
},
                                                                            563
   "id": "statement:coal_tit_bar",
   "taxon": "taxon:periparus_ater";
                                                                            565
```

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"character": "character:wing_bar",

```
"value": "state:wing_bar",
                                                                                 567
          "frequency": 1
                                                                                 568
      },
                                                                                 569
      {
          "id": "statement:poecile_palustris_cheek_back",
                                                                                 571
          "taxon": "taxon:poecile_palustris",
                                                                                 572
          "character": "character:black_of_cheek",
                                                                                 573
          "value": "state:brown_cheek_back",
          "frequency": 1
                                                                                 575
      },
                                                                                 576
                                                                                 577
          "id": "statement:poecile_montanus_cheek_back",
          "taxon": "taxon:poecile_montanus",
                                                                                 579
          "character": "character:black_of_cheek",
          "value": "state:white_cheek_back",
                                                                                 581
          "frequency": 1
      },
                                                                                 583
      {
                                                                                 584
          "id": "statement:poecile_palustris_wing_secondaries_color",
          "taxon": "taxon:poecile_palustris",
                                                                                 586
          "character": "character:wing_secondaries_color",
                                                                                 587
          "value": "state:secondaries_not_pale",
                                                                                 588
          "frequency": 1
      },
                                                                                 590
      {
          "id": "statement:poecile_montanus_wing_secondaries_color",
                                                                                 592
          "taxon": "taxon:poecile_montanus",
                                                                                 593
          "character": "character:wing_secondaries_color",
                                                                                 594
          "value": "state:secondaries_pale",
          "frequency": 1
                                                                                 596
      }
   ]
                                                                                 598
}
                                                                                 599
```

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