S3 Appendix. Titmice key example

```
{
   "$schema": "https://raw.githubusercontent.com/Artsdatabanken/Clavis/
60090011e4efed657f41cced3366b2b57d6cff3b/Clavis.json",
   "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",
   "regionMultiPolygon": [
         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
         ],
         Γ
            11.953125,
            58.83649009392136
         ],
            13.3154296875,
            61.39671887310411
         ],
         12.8759765625,
            63.6267446447533
         ],
         14.94140625,
            64.07219957867282
         ],
         Γ
            15.2490234375,
            66.05371622067922
         ],
            18.852539062499996,
            68.02402198693447
         ],
         25.048828125,
            68.51214331858073
         ],
         Γ
            26.894531249999996,
            69.54987728327795
         ],
         29.003906249999996,
            68.8159271333607
         ],
            33.22265625,
            69.56522590149099
      ]
   ]
],
"persons": [
      "id": "person:wouterkoch",
      "name": "Wouter Koch"
   }
],
"organizations": [
```

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```
{
                                                                                 99
       "id": "organization:ntnu",
                                                                                100
       "name": "Norwegian University of Science and Technology",
                                                                                101
       "url": "https://www.ntnu.no"
                                                                                102
   }
                                                                                103
],
                                                                                104
"externalServices": [
                                                                                105
       "id": "service:nbic_taxa",
                                                                                107
       "title": "NBIC taxonomy scientificNameId",
                                                                                108
       "provider": "Norwegian Biodiversity Information Centre",
                                                                                109
       "url": "https://www.artsdatabanken.no/help"
   }
                                                                                111
],
                                                                                112
"taxa": [
                                                                                113
   {
                                                                                114
       "id": "taxon:paridae",
                                                                                115
       "scientificName": "Paridae",
                                                                                116
       "rank": "family",
                                                                                117
       "vernacularName": "titmice",
                                                                                118
       "externalResource": {
                                                                                119
          "serviceId": "service:nbic_taxa",
                                                                                120
          "externalId": "4362"
      },
                                                                                122
       "children": [
          {
                                                                                124
             "id": "taxon:cyanistes",
                                                                                125
              "scientificName": "Cyanistes",
                                                                                126
             "rank": "genus",
              "externalResource": {
                                                                                128
                 "serviceId": "service:nbic_taxa",
                 "externalId": "4364"
                                                                                130
             },
                                                                                131
             "children": [
                                                                                132
                 {
                                                                                133
                    "id": "taxon:cyanistes_caeruleus",
                                                                                134
                    "scientificName": "Cyanistes caeruleus",
                                                                                135
                    "vernacularName": "blue tit",
                    "rank": "species",
                                                                                137
                    "externalResource": {
                                                                                138
                        "serviceId": "service:nbic_taxa",
                                                                                139
                        "externalId": "4365"
                                                                                141
                 }
                                                                                142
             ]
                                                                                143
          },
          {
                                                                                145
             "id": "taxon:lophophanes",
              "scientificName": "Lophophanes",
                                                                                147
              "rank": "genus",
                                                                                148
              "externalResource": {
                                                                                149
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"serviceId": "service:nbic_taxa",

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```
"externalId": "4368"
                                                                      151
                                                                      152
"children": [
                                                                      153
   {
       "id": "taxon:lophophanes_cristatus",
                                                                      155
       "scientificName": "Lophophanes cristatus",
                                                                      156
       "vernacularName": "crested tit",
                                                                      157
       "rank": "species",
       "externalResource": {
                                                                      159
          "serviceId": "service:nbic_taxa",
                                                                      160
          "externalId": "4369"
                                                                      161
      },
       "geoDistribution": [
                                                                      163
          164
              Г
                                                                      165
                 166
                     11.997070312499998,
                                                                      167
                     58.74540696858028
                                                                      168
                 ],
                                                                      170
                     13.0517578125,
                                                                      171
                     59.977005492196
                                                                      172
                 ],
                                                                      174
                     12.8759765625,
                     63.31268278043484
                                                                      176
                 ],
                                                                      177
                                                                      178
                     19.2041015625,
                     68.57644086491786
                                                                      180
                 ],
                                                                      181
                                                                      182
                     13.4912109375,
                                                                      183
                     68.78414378041504
                                                                      184
                 ],
                                                                      185
                 Γ
                                                                      186
                    9.7119140625,
                                                                      187
                     64.47279382008166
                 ],
                                                                      189
                 [
                     4.21875,
                                                                      191
                    62.2679226294176
                 ],
                                                                      193
                                                                      194
                     3.69140625,
                                                                      195
                     59.40036514079251
                 ],
                                                                      197
                    6.723632812499999,
                                                                      199
                    57.70414723434193
                                                                      200
                 ],
                                                                      201
                 Γ
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},

```
11.997070312499998,
                      58.74540696858028
                  ]
               ]
            ]
         ]
      }
   ]
},
{
   "id": "taxon:parus",
   "scientificName": "Parus",
   "rank": "genus",
   "externalResource": {
      "serviceId": "service:nbic_taxa",
      "externalId": "4363"
   },
   "children": [
      {
         "id": "taxon:parus_major",
         "scientificName": "Parus major",
         "vernacularName": "great tit",
         "rank": "species",
         "externalResource": {
             "serviceId": "service:nbic_taxa",
            "externalId": "4372"
         }
      }
   ]
},
   "id": "taxon:periparus",
   "scientificName": "Periparus",
   "rank": "genus",
   "externalResource": {
      "serviceId": "service:nbic_taxa",
      "externalId": "4374"
   },
   "children": [
      {
         "id": "taxon:periparus_ater",
         "scientificName": "Periparus ater",
         "vernacularName": "coal tit",
         "rank": "species",
         "externalResource": {
             "serviceId": "service:nbic_taxa",
             "externalId": "4375"
         }
      }
   ]
},
{
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```
"id": "taxon:poecile",
"scientificName": "Poecile",
"rank": "genus",
"externalResource": {
   "serviceId": "service:nbic_taxa",
   "externalId": "4378"
},
"children": [
   {
      "id": "taxon:poecile_palustris",
      "scientificName": "Poecile palustris",
      "vernacularName": "marsh tit",
      "rank": "species",
      "externalResource": {
         "serviceId": "service:nbic_taxa",
         "externalId": "4385"
      },
      "geoDistribution": [
         11.997070312499998,
                  58.74540696858028
               ],
                  13.0517578125,
                  59.977005492196
               ],
                  12.8759765625,
                  63.31268278043484
               ],
               19.2041015625,
                  68.57644086491786
               ],
                  13.4912109375,
                  68.78414378041504
               ],
                  9.7119140625,
                  64.47279382008166
               ],
               4.21875,
                  62.2679226294176
               ],
                  3.69140625,
                  59.40036514079251
               ],
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Γ
                               6.723632812499999,
                               57.70414723434193
                            ],
                            [
                               11.997070312499998,
                               58.74540696858028
                            ]
                      ]
                  ]
               },
               {
                   "id": "taxon:poecile_montanus",
                   "scientificName": "Poecile montanus",
                   "vernacularName": "willow tit",
                   "rank": "species",
                   "externalResource": {
                      "serviceId": "service:nbic_taxa",
                      "externalId": "4382"
                  }
               },
                   "id": "taxon:poecile_cinctus",
                   "scientificName": "Poecile cinctus",
                   "vernacularName": "Siberian tit",
                   "rank": "species",
                   "externalResource": {
                      "serviceId": "service:nbic_taxa",
                      "externalId": "4379"
                  }
               }
            ]
         }
      ]
   }
],
"characters": [
   {
      "id": "character:head_top",
      "title": "Top of the head",
      "states": [
         {
            "id": "state:black_or_dark_grey",
            "title": "Black or dark grey"
         },
            "id": "state:blue",
            "title": "Blue"
         },
         {
            "id": "state:speckled_crest",
```

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```
"title": "Speckled black and white, with a crest"
   ]
},
   "id": "character:head_top",
   "title": "Top of the head",
   "states": [
      {
         "id": "state:black_or_dark_grey",
         "title": "Black or dark grey"
      },
         "id": "state:brown",
         "title": "Brown"
      },
         "id": "state:blue",
         "title": "Blue"
      },
         "id": "state:speckled_crest",
         "title": "Speckled black and white, with a crest"
   ]
},
   "id": "character:chest_color",
   "title": "Color of the chest",
   "states": [
      {
         "id": "state:yellow",
         "title": "Yellow"
      },
         "id": "state:grey_brown",
         "title": "Grey to brown"
      }
   ]
},
   "id": "character:wing_bar",
   "title": "White bar on the wing",
   "states": [
      {
         "id": "state:wing_bar",
         "title": "Present"
      },
      {
         "id": "state:no_wing_bar",
         "title": "Absent"
      }
```

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```
1
                                                                                411
   },
                                                                                412
   {
                                                                                413
      "id": "character:black_of_cheek",
                                                                                414
      "title": "Color of the cheek at the back",
                                                                                415
      "states": [
                                                                                416
          {
                                                                                417
             "id": "state:white_cheek_back",
             "title": "Entire cheek white"
                                                                                419
         },
                                                                                420
          {
                                                                                421
             "id": "state:brown_cheek_back",
             "title": "Sullied brown"
                                                                                423
          }
      ٦
                                                                                425
   },
   {
                                                                                427
      "id": "character:wing_secondaries_color",
                                                                                428
      "title": "Color of secondary wing feathers",
      "states": [
                                                                                430
          {
                                                                                431
             "id": "state:secondaries_pale",
                                                                                432
             "title": "Paler than rest of the wing"
         },
                                                                                434
          {
             "id": "state:secondaries_not_pale",
                                                                                436
             "title": "No clear different from rest of the wing"
                                                                                437
                                                                                438
      ]
   }
                                                                                440
],
"statements": [
                                                                                442
   {
                                                                                443
      "id": "statement:crested_tit_head",
      "taxonId": "taxon:lophophanes_cristatus",
                                                                                445
      "characterId": "character:head_top",
                                                                                446
      "value": "state:speckled_crest",
                                                                                447
      "frequency": 1
   },
                                                                                449
   {
                                                                                450
      "id": "statement:blue_tit_head",
                                                                                451
      "taxonId": "taxon:cyanistes_caeruleus",
      "characterId": "character:head_top",
                                                                                453
      "value": "state:blue",
                                                                                454
      "frequency": 1
                                                                                455
   },
   {
                                                                                457
      "id": "statement:poecile_palustris_head",
      "taxonId": "taxon:poecile_palustris",
                                                                                459
      "characterId": "character:head_top",
      "value": "state:black_or_dark_grey",
                                                                                461
      "frequency": 1
                                                                                462
```

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```
},
                                                                            463
{
                                                                            464
   "id": "statement:poecile_montanus_head",
                                                                            465
   "taxonId": "taxon:poecile_montanus",
   "characterId": "character:head_top",
                                                                            467
   "value": "state:black_or_dark_grey",
                                                                            468
   "frequency": 1
                                                                            469
},
{
                                                                            471
   "id": "statement:poecile_cinctus_head",
                                                                            472
   "taxonId": "taxon:poecile_cinctus",
                                                                            473
   "characterId": "character:head_top",
   "value": "state:brown",
                                                                            475
   "frequency": 1
                                                                            476
},
                                                                            477
   "id": "statement:great_tit_head",
                                                                            479
   "taxonId": "taxon:parus_major",
                                                                            480
   "characterId": "character:head_top",
                                                                            481
   "value": "state:black_or_dark_grey",
                                                                            482
   "frequency": 1
                                                                            483
},
                                                                            484
{
   "id": "statement:coal_tit_head",
                                                                            486
   "taxonId": "taxon:periparus_ater",
   "characterId": "character:head_top",
                                                                            488
   "value": "state:black_or_dark_grey",
   "frequency": 1
                                                                            490
},
{
                                                                            492
   "id": "statement:crested_tit_chest",
   "taxonId": "taxon:lophophanes_cristatus",
                                                                            494
   "characterId": "character:chest_color",
                                                                            495
   "value": "state:grey_brown",
   "frequency": 1
                                                                            497
},
                                                                            498
{
                                                                            499
   "id": "statement:blue_tit_chest",
   "taxonId": "taxon:cyanistes_caeruleus",
                                                                            501
   "characterId": "character:chest_color",
                                                                            502
   "value": "state:yellow",
                                                                            503
   "frequency": 1
},
                                                                            505
{
                                                                            506
   "id": "statement:poecile_chest",
                                                                            507
   "taxonId": "taxon:poecile",
   "characterId": "character:chest_color",
                                                                            509
   "value": "state:grey_brown",
                                                                            510
   "frequency": 1
                                                                            511
},
                                                                            512
{
                                                                            513
   "id": "statement:great_tit_chest",
                                                                            514
```

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

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"value": "state:brown_cheek_back",

```
"frequency": 1
                                                                                 567
      },
                                                                                 568
      {
                                                                                 569
          "id": "statement:poecile_montanus_cheek_back",
          "taxonId": "taxon:poecile_montanus",
                                                                                 571
          "characterId": "character:black_of_cheek",
                                                                                 572
          "value": "state:white_cheek_back",
                                                                                 573
          "frequency": 1
      },
                                                                                 575
      {
          "id": "statement:poecile_palustris_wing_secondaries_color",
                                                                                 577
          "taxonId": "taxon:poecile_palustris",
          "characterId": "character:wing_secondaries_color",
                                                                                 579
          "value": "state:secondaries_not_pale",
          "frequency": 1
                                                                                 581
      },
      {
                                                                                 583
          "id": "statement:poecile_montanus_wing_secondaries_color",
                                                                                 584
          "taxonId": "taxon:poecile_montanus",
          "characterId": "character:wing_secondaries_color",
                                                                                 586
          "value": "state:secondaries_pale",
                                                                                 587
          "frequency": 1
                                                                                 588
      }
   ]
                                                                                 590
}
                                                                                 592
```

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