S3 Appendix. Titmice key example

```
1  {
2      "$schema":
3  "https://raw.githubusercontent.com/WouterKoch/Clavis/main/Schema/Clavi
4  s.json",
5      "title": "A key to titmice in Norway",
6      "language": "en",
7      "license": "https://creativecommons.org/licenses/by/4.0/",
8      "creator": "person:wouterkoch",
9      "lastModified": "2022-03-19 21:41:00",
10     "identifier": "9be11d7e-c147-400a-899e-b3d5e4bcc6a1",
11     "geography": {
12        "name": "Norway",
13        "polygon": [
14           [
15              [
16                 [
17                    33.22265625,
18                    69.56522590149099
19                 ],
20                 [
21                    29.267578125,
22                    71.15939141681443
23                 ],
24                 [
25                    23.5546875,
26                    71.28669893545877
27                 ],
28                 [
29                    17.2265625,
30                    69.97549253616164
31                 ],
32                 [
33                    12.392578125,
34                    68.366801093914
35                 ],
36                 [
37                    11.2939453125,
38                    65.91062334197893
39                 ],
```

```
            [
                3.8671874999999996,
                62.103882522897855
            ],
            [
                4.7021484375,
                58.516651799363785
            ],
            [
                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,
```

```
 86                    68.8159271333607
 87                 ],
 88                 [
 89                    33.22265625,
 90                    69.56522590149099
 91                 ]
 92              ]
 93           ]
 94        ]
 95     },
 96     "persons": [
 97        {
 98           "id": "person:wouterkoch",
 99           "name": "Wouter Koch"
100        }
101     ],
102     "externalServices": [
103        {
104           "id": "service:nbic_taxa",
105           "title": "NBIC taxonomy scientificNameId",
106           "description": "To retrieve taxon information based on the
107 NBIC scientificNameId, e.g. through
108 https://www.artsdatabanken.no/api/Taxon/ByScientificNameId/4362",
109           "provider": "Norwegian Biodiversity Information Centre",
110           "url": "https://www.artsdatabanken.no/help"
111        }
112     ],
113     "taxa": [
114        {
115           "id": "taxon:paridae",
116           "scientificName": "Paridae",
117           "rank": "family",
118           "vernacularName": "titmice",
119           "externalReference": {
120              "serviceId": "service:nbic_taxa",
121              "externalId": "4362"
122           },
123           "children": [
124              {
125                 "id": "taxon:cyanistes",
126                 "scientificName": "Cyanistes",
127                 "rank": "genus",
128                 "externalReference": {
129                    "serviceId": "service:nbic_taxa",
130                    "externalId": "4364"
131                 },
```

3

```
            "children": [
                {
                    "id": "taxon:cyanistes_caeruleus",
                    "scientificName": "Cyanistes caeruleus",
                    "vernacularName": "blue tit",
                    "rank": "species",
                    "externalReference": {
                        "serviceId": "service:nbic_taxa",
                        "externalId": "4365"
                    }
                }
            ]
        },
        {
            "id": "taxon:lophophanes",
            "scientificName": "Lophophanes",
            "rank": "genus",
            "externalReference": {
                "serviceId": "service:nbic_taxa",
                "externalId": "4368"
            },
            "children": [
                {
                    "id": "taxon:lophophanes_cristatus",
                    "scientificName": "Lophophanes cristatus",
                    "vernacularName": "crested tit",
                    "rank": "species",
                    "externalReference": {
                        "serviceId": "service:nbic_taxa",
                        "externalId": "4369"
                    },
                    "geography": {
                        "polygon": [
                            [
                                [
                                    [
                                        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
                    ],
                    [
                        6.723632812499999,
                        57.70414723434193
                    ],
                    [
                        11.997070312499998,
                        58.74540696858028
                    ]
                ]
            ]
        ]
    }
}
    ]
},
{
    "id": "taxon:parus",
    "scientificName": "Parus",
    "rank": "genus",
    "externalReference": {
        "serviceId": "service:nbic_taxa",
        "externalId": "4363"
    },
    "children": [
        {
```

```json
                    "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",
                        "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",
```

```
270                     "externalReference": {
271                        "serviceId": "service:nbic_taxa",
272                        "externalId": "4385"
273                     },
274                     "geography": {
275                        "polygon": [
276                           [
277                              [
278                                 [
279                                    11.997070312499998,
280                                    58.74540696858028
281                                 ],
282                                 [
283                                    13.0517578125,
284                                    59.977005492196
285                                 ],
286                                 [
287                                    12.8759765625,
288                                    63.31268278043484
289                                 ],
290                                 [
291                                    19.2041015625,
292                                    68.57644086491786
293                                 ],
294                                 [
295                                    13.4912109375,
296                                    68.78414378041504
297                                 ],
298                                 [
299                                    9.7119140625,
300                                    64.47279382008166
301                                 ],
302                                 [
303                                    4.21875,
304                                    62.2679226294176
305                                 ],
306                                 [
307                                    3.69140625,
308                                    59.40036514079251
309                                 ],
310                                 [
311                                    6.723632812499999,
312                                    57.70414723434193
313                                 ],
314                                 [
315                                    11.997070312499998,
```

```
316                                      58.74540696858028
317                                  ]
318                              ]
319                          ]
320                      ]
321                  }
322              },
323              {
324                  "id": "taxon:poecile_montanus",
325                  "scientificName": "Poecile montanus",
326                  "vernacularName": "willow tit",
327                  "rank": "species",
328                  "externalReference": {
329                      "serviceId": "service:nbic_taxa",
330                      "externalId": "4382"
331                  }
332              },
333              {
334                  "id": "taxon:poecile_cinctus",
335                  "scientificName": "Poecile cinctus",
336                  "vernacularName": "Siberian tit",
337                  "rank": "species",
338                  "externalReference": {
339                      "serviceId": "service:nbic_taxa",
340                      "externalId": "4379"
341                  }
342              }
343          ]
344      }
345  ]
346  }
347  ],
348  "characters": [
349      {
350          "id": "character:head_top",
351          "title": "Top of the head",
352          "states": [
353              {
354                  "id": "state:black_or_dark_grey",
355                  "title": "Black or dark grey"
356              },
357              {
358                  "id": "state:blue",
359                  "title": "Blue"
360              },
361              {
```

```json
                    "id": "state:speckled_crest",
                    "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": [
                {
```

```
408              "id": "state:wing_bar",
409              "title": "Present"
410            },
411            {
412              "id": "state:no_wing_bar",
413              "title": "Absent"
414            }
415          ]
416        },
417        {
418          "id": "character:black_of_cheek",
419          "title": "Color of the cheek at the back",
420          "states": [
421            {
422              "id": "state:white_cheek_back",
423              "title": "Entire cheek white"
424            },
425            {
426              "id": "state:brown_cheek_back",
427              "title": "Sullied brown"
428            }
429          ]
430        },
431        {
432          "id": "character:wing_secondaries_color",
433          "title": "Color of secondary wing feathers",
434          "states": [
435            {
436              "id": "state:secondaries_pale",
437              "title": "Paler than rest of the wing"
438            },
439            {
440              "id": "state:secondaries_not_pale",
441              "title": "No clear different from rest of the wing"
442            }
443          ]
444        }
445      ],
446      "statements": [
447        {
448          "id": "statement:crested_tit_head",
449          "taxon": "taxon:lophophanes_cristatus",
450          "character": "character:head_top",
451          "value": "state:speckled_crest",
452          "frequency": 1
453        },
```

```
454          {
455              "id": "statement:blue_tit_head",
456              "taxon": "taxon:cyanistes_caeruleus",
457              "character": "character:head_top",
458              "value": "state:blue",
459              "frequency": 1
460          },
461          {
462              "id": "statement:poecile_palustris_head",
463              "taxon": "taxon:poecile_palustris",
464              "character": "character:head_top",
465              "value": "state:black_or_dark_grey",
466              "frequency": 1
467          },
468          {
469              "id": "statement:poecile_montanus_head",
470              "taxon": "taxon:poecile_montanus",
471              "character": "character:head_top",
472              "value": "state:black_or_dark_grey",
473              "frequency": 1
474          },
475          {
476              "id": "statement:poecile_cinctus_head",
477              "taxon": "taxon:poecile_cinctus",
478              "character": "character:head_top",
479              "value": "state:brown",
480              "frequency": 1
481          },
482          {
483              "id": "statement:great_tit_head",
484              "taxon": "taxon:parus_major",
485              "character": "character:head_top",
486              "value": "state:black_or_dark_grey",
487              "frequency": 1
488          },
489          {
490              "id": "statement:coal_tit_head",
491              "taxon": "taxon:periparus_ater",
492              "character": "character:head_top",
493              "value": "state:black_or_dark_grey",
494              "frequency": 1
495          },
496          {
497              "id": "statement:crested_tit_chest",
498              "taxon": "taxon:lophophanes_cristatus",
499              "character": "character:chest_color",
```

```
500          "value": "state:grey_brown",
501          "frequency": 1
502      },
503      {
504          "id": "statement:blue_tit_chest",
505          "taxon": "taxon:cyanistes_caeruleus",
506          "character": "character:chest_color",
507          "value": "state:yellow",
508          "frequency": 1
509      },
510      {
511          "id": "statement:poecile_chest",
512          "taxon": "taxon:poecile",
513          "character": "character:chest_color",
514          "value": "state:grey_brown",
515          "frequency": 1
516      },
517      {
518          "id": "statement:great_tit_chest",
519          "taxon": "taxon:parus_major",
520          "character": "character:chest_color",
521          "value": "state:yellow",
522          "frequency": 1
523      },
524      {
525          "id": "statement:coal_tit_chest",
526          "taxon": "taxon:periparus_ater",
527          "character": "character:chest_color",
528          "value": "state:grey_brown",
529          "frequency": 1
530      },
531      {
532          "id": "statement:crested_tit_bar",
533          "taxon": "taxon:lophophanes_cristatus",
534          "character": "character:wing_bar",
535          "value": "state:no_wing_bar",
536          "frequency": 1
537      },
538      {
539          "id": "statement:blue_tit_bar",
540          "taxon": "taxon:cyanistes_caeruleus",
541          "character": "character:wing_bar",
542          "value": "state:wing_bar",
543          "frequency": 1
544      },
545      {
```

```
546            "id": "statement:poecile_bar",
547            "taxon": "taxon:poecile",
548            "character": "character:wing_bar",
549            "value": "state:no_wing_bar",
550            "frequency": 1
551        },
552        {
553            "id": "statement:great_tit_bar",
554            "taxon": "taxon:parus_major",
555            "character": "character:wing_bar",
556            "value": "state:wing_bar",
557            "frequency": 1
558        },
559        {
560            "id": "statement:coal_tit_bar",
561            "taxon": "taxon:periparus_ater",
562            "character": "character:wing_bar",
563            "value": "state:wing_bar",
564            "frequency": 1
565        },
566        {
567            "id": "statement:poecile_palustris_cheek_back",
568            "taxon": "taxon:poecile_palustris",
569            "character": "character:black_of_cheek",
570            "value": "state:brown_cheek_back",
571            "frequency": 1
572        },
573        {
574            "id": "statement:poecile_montanus_cheek_back",
575            "taxon": "taxon:poecile_montanus",
576            "character": "character:black_of_cheek",
577            "value": "state:white_cheek_back",
578            "frequency": 1
579        },
580        {
581            "id": "statement:poecile_palustris_wing_secondaries_color",
582            "taxon": "taxon:poecile_palustris",
583            "character": "character:wing_secondaries_color",
584            "value": "state:secondaries_not_pale",
585            "frequency": 1
586        },
587        {
588            "id": "statement:poecile_montanus_wing_secondaries_color",
589            "taxon": "taxon:poecile_montanus",
590            "character": "character:wing_secondaries_color",
591            "value": "state:secondaries_pale",
```

```
592              "frequency": 1
593          }
594      ]
595  }
596
```