S1 Appendix. Clavis JSON-schema

```
{
  "$schema": "http://json-schema.org/draft-07/schema#",
  "title": "Clavis identification key schema",
  "description": "Clavis-compliant keys contain knowledge that may be
used to distinguish taxa from each other.",
  "type": "object",
  "required": [
    "$schema",
    "title",
    "language",
    "license",
    "creator",
    "lastModified",
    "identifier",
    "taxa",
    "characters",
    "statements"
  ],
  "properties": {
    "$schema": {
      "description": "The schema url of (this) schema defining the
format of the key.",
      "$ref": "#/definitions/url"
    },
    "title": {
      "description": "The name of the key",
      "comment": "Accepts array for multilingual support.",
      "$ref": "#/definitions/localizedString",
      "examples": [
        "Birds of Norway"
      ٦
    },
    "media": {
      "description": "The logo/illustration image of the key.",
      "$ref": "#/definitions/mediaID"
    "description": {
      "description": "Short description of the key (valid markdown).",
      "comment": "Accepts array for multilingual support.",
      "$ref": "#/definitions/localizedString",
      "contentMediaType": "text/markdown"
    },
    "descriptionDetails": {
      "description": "Extended description of the key that supplements
the description (valid markdown).",
```

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```
"comment": "Accepts array for multilingual support.",
                                                                             47
      "$ref": "#/definitions/localizedString",
      "contentMediaType": "text/markdown"
    },
    "descriptionUrl": {
      "description": "Hyperlink to more information on the key (valid
url).",
      "comment": "Accepts array for multilingual support.",
      "$ref": "#/definitions/localizedUrl"
    },
    "audience": {
      "description": "Description of the intended audience for the
key.",
      "comment": "Accepts array for multilingual support.",
      "$ref": "#/definitions/localizedString",
      "examples": [
        "Undergraduate students and up."
      ٦
    },
    "source": {
      "description": "Source of the key.",
      "comment": "Accepts array for multilingual support.",
      "$ref": "#/definitions/localizedString",
      "examples": [
        "Koch, Wouter (2019). Birds of Norway. ISBN 1234567890"
    },
    "sourceUrl": {
      "description": "Hyperlink to the source of the key (valid url).",
      "comment": "Accepts array for multilingual support.",
      "$ref": "#/definitions/localizedUrl",
      "examples": [
        "https://doi.org/10.1126/science.1251554"
      ٦
    },
    "geography": {
      "description": "The region for which the key is valid (e.g. covers
all subtaxa), represented as a geography object.",
      "$ref": "#/definitions/geography"
    },
    "primaryContact": {
      "description": "The organization- or person-id that is the main
contact point for the key.",
      "oneOf": [
          "$ref": "#/definitions/personID"
        },
          "$ref": "#/definitions/organizationID"
        }
      ]
    },
```

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```
"creator": {
                                                                                      99
       "description": "The id(s) of the creator(s) of the key",
                                                                                     100
       "oneOf": [
                                                                                     101
                                                                                     102
           "$ref": "#/definitions/personID"
                                                                                     103
         },
                                                                                     104
                                                                                     105
            "type": "array",
            "items": {
                                                                                     107
              "$ref": "#/definitions/personID"
                                                                                     108
                                                                                     109
         }
       ]
                                                                                     111
    },
                                                                                     112
    "contributor": {
                                                                                     113
       "description": "The id(s) of the contributor(s) of the key",
                                                                                     114
       "oneOf": [
                                                                                     115
         {
                                                                                     116
            "$ref": "#/definitions/personID"
                                                                                     117
         },
                                                                                     118
                                                                                     119
           "type": "array",
                                                                                     120
            "items": {
              "$ref": "#/definitions/personID"
                                                                                     122
         }
                                                                                     124
       ]
                                                                                     125
    },
                                                                                     126
     "publisher": {
       "description": "The id(s) of the publishing institutions of the
                                                                                     128
key.",
       "oneOf": [
                                                                                     130
         {
                                                                                     131
            "$ref": "#/definitions/organizationID"
                                                                                     132
         },
                                                                                     133
         {
                                                                                     134
           "type": "array",
                                                                                     135
            "items": {
              "$ref": "#/definitions/organizationID"
                                                                                     137
         }
                                                                                     139
       ]
    },
                                                                                     141
    "license": {
                                                                                     142
       "description": "The url to the license under which the key
                                                                                     143
falls.",
       "$ref": "#/definitions/url",
                                                                                     145
       "examples": [
         "https://creativecommons.org/licenses/by/4.0/"
                                                                                     147
       ]
                                                                                     148
    },
                                                                                     149
    "language": {
                                                                                     150
```

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```
"description": "The ISO 639-1 code(s) of the key language(s).",
                                                                                   151
      "comment": "String for a single language, array of strings for
                                                                                   152
multilingual support. If used as an array, be sure to use the
                                                                                   153
localizedString and localizedUrl as arrays too.",
       "oneOf": [
                                                                                   155
                                                                                   156
           "type": "string",
                                                                                   157
           "pattern": "^[a-z]{2}$"
        },
                                                                                   159
                                                                                   160
           "type": "array",
                                                                                   161
           "items": \{
             "type": "string",
                                                                                   163
             "pattern": "^[a-z]{2}$"
                                                                                   164
                                                                                   165
        }
                                                                                   166
      ],
                                                                                   167
      "examples": [
                                                                                   168
         "en",
         "nb"
                                                                                   170
         171
           "en",
                                                                                   172
           "nb"
                                                                                   174
      ]
    },
                                                                                   176
    "created": {
      "description": "The moment the key was made or first published, as
                                                                                   178
'YYYY-MM-DD hh:mm:ss'.",
      "type": "string",
                                                                                   180
       "pattern": "^20\d\d-(0[1-9]|1[0-2])-([012]\d|3[01])
                                                                                   181
([01]\d|2[0-3]):([0-5]\d):([0-5]\d)",
                                                                                   182
      "examples": [
                                                                                   183
         "2019-05-21 22:51:55"
                                                                                   184
      ]
                                                                                   185
    },
                                                                                   186
    "lastModified": {
                                                                                   187
      "description": "The most recent moment the key was modified, as
'YYYY-MM-DD hh:mm:ss'.",
                                                                                   189
      "type": "string",
      "pattern": "^20\d\d-(0[1-9]|1[0-2])-([012]\d|3[01])
                                                                                   191
([01]\d|2[0-3]):([0-5]\d):([0-5]\d)",
      "examples": [
                                                                                   193
         "2019-05-21 22:51:55"
                                                                                   194
      ]
                                                                                   195
    },
    "identifier": {
                                                                                   197
      "description": "The GUID of this key (persistent regardless of
version).",
                                                                                   199
      "type": "string"
                                                                                   200
    },
                                                                                   201
    "url": {
                                                                                   202
```

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```
"description": "The url of where the key lives (to check for newer
                                                                                 203
versions).",
                                                                                 204
      "$ref": "#/definitions/url"
                                                                                 205
    },
    "externalServices": {
                                                                                 207
      "description": "Services used by the key for lookups of images,
taxa, etc.",
                                                                                 209
      "type": "array",
      "items": {
                                                                                 211
        "$ref": "#/definitions/externalService"
                                                                                 212
                                                                                 213
    },
    "userRequirements": {
                                                                                 215
      "description": "Requirements to the users of the various
                                                                                 216
characters, so that the user can be warned, helped, etc.",
                                                                                 217
      "type": "array",
                                                                                 218
      "items": {
                                                                                 219
        "$ref": "#/definitions/userRequirement"
                                                                                 220
      }
                                                                                 221
    },
                                                                                 222
    "taxa": {
                                                                                 223
      "description": "Taxa (e.g. species) the key can resolve to. Do not
                                                                                 224
have to be exclusively taxonomic units.",
      "comment": "Taxa to which the key can resolve (either the taxa
                                                                                 226
directly or their children).",
      "type": "array",
                                                                                 228
      "items": {
        "$ref": "#/definitions/taxon"
                                                                                 230
      }
    },
                                                                                 232
    "characters": {
      "description": "Characters (questions, e.g. 'Wing color' or
                                                                                 234
'Number of spots') used to distinguish between two or more taxa.",
                                                                                 235
      "type": "array",
      "items": {
                                                                                 237
        "$ref": "#/definitions/character"
                                                                                 238
      }
                                                                                 239
    },
    "statements": {
                                                                                 241
      "description": "Relationships between taxa and character states
(or lack thereof) that define those taxa.",
                                                                                 243
      "type": "array",
      "items": {
                                                                                 245
        "$ref": "#/definitions/statement"
                                                                                 246
      }
                                                                                 247
    },
    "persons": {
                                                                                 249
      "description": "Persons that are connected to (parts of) the key,
such as creators.",
                                                                                 251
      "type": "array",
      "items": {
                                                                                 253
        "$ref": "#/definitions/person"
                                                                                 254
```

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```
}
                                                                                   255
    },
                                                                                   256
    "organizations": {
                                                                                   257
      "description": "Organizations that are connected to (parts of) the
key or persons, such as employers and publishers.",
                                                                                   259
      "type": "array",
      "items": {
                                                                                   261
         "$ref": "#/definitions/organization"
                                                                                   263
    },
                                                                                   264
    "mediaElements": {
      "description": "Media elements that are used in the key.",
      "type": "array",
                                                                                   267
      "items": {
         "$ref": "#/definitions/localizedMediaElement"
                                                                                   269
                                                                                   270
    }
                                                                                   271
  },
                                                                                   272
  "additionalProperties": false,
                                                                                   273
  "definitions": {
                                                                                   274
    "localizedString": {
                                                                                   275
      "description": "Language-dependent string or object of strings,
                                                                                   276
with keys corresponding to the languages supported by the key.",
      "oneOf": [
                                                                                   278
         {
           "type": "string"
                                                                                   280
        },
                                                                                   281
                                                                                   282
           "type": "object",
           "propertyNames": {
                                                                                   284
             "pattern": "^[a-z]{2}$"
           },
                                                                                   286
           "properties": {},
                                                                                   287
           "additionalProperties": {
                                                                                   288
             "type": "string"
                                                                                   289
                                                                                   290
        }
                                                                                   291
      ]
    },
                                                                                   293
    "localizedUrl": {
      "description": "Language-dependent urls or object of urls,
                                                                                   295
corresponding to the languages supported by the key.",
      "oneOf": [
                                                                                   297
           "$ref": "#/definitions/url"
        },
                                                                                   301
           "type": "object",
           "propertyNames": {
                                                                                   303
             "pattern": "^[a-z]{2}$"
                                                                                   304
           },
                                                                                   305
           "properties": {},
                                                                                   306
```

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```
"additionalProperties": {
                                                                                   307
             "$ref": "#/definitions/url"
                                                                                   308
                                                                                   309
        }
      ]
                                                                                   311
    },
                                                                                   312
    "localizedMediaElement": {
                                                                                   313
      "type": "object",
      "description": "Language-dependent media element or object of
                                                                                   315
media elements, corresponding to the languages supported by the key.",
                                                                                   316
      "properties": {
                                                                                   317
         "id": {
           "description": "Internally unique id of the localized media
                                                                                   319
element.",
           "$ref": "#/definitions/mediaID"
                                                                                   321
        },
         "mediaElement": {
                                                                                   323
           "description": "The media element or media elements (one for
                                                                                   324
each language).",
           "oneOf": [
                                                                                   326
                                                                                   327
               "$ref": "#/definitions/mediaElement"
                                                                                   328
             },
                                                                                   330
               "type": "object",
               "propertyNames": {
                                                                                   332
                  "pattern": "^[a-z]{2}$"
                                                                                   333
               },
                                                                                   334
               "properties": {},
               "additionalProperties": {
                                                                                   336
                  "$ref": "#/definitions/mediaElement"
                                                                                   338
             }
                                                                                   339
           ]
        }
                                                                                   341
      },
                                                                                   342
      "additionalProperties": false
                                                                                   343
    },
    "url": {
                                                                                   345
      "description": "String formed as a url, or an external
resource.",
                                                                                   347
      "oneOf": [
                                                                                   349
           "type": "string",
                                                                                   350
           "format": "uri"
                                                                                   351
        },
         {
                                                                                   353
           "$ref": "#/definitions/externalResource"
                                                                                   355
      ]
    },
                                                                                   357
    "taxonID": {
                                                                                   358
```

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```
"description": "String used as an internal ID for a taxon.
                                                                               359
Lowercase alphanumeric and underscores are allowed.",
                                                                               360
      "type": "string",
                                                                               361
      "pattern": "^taxon:[a-z0-9_]+$"
    },
                                                                               363
    "characterID": {
      "description": "String used as an internal ID for a character.
                                                                               365
Lowercase alphanumeric and underscores are allowed.",
      "type": "string",
                                                                               367
      "pattern": "^character:[a-z0-9_]+$"
    },
    "stateID": {
      "description": "String used as an internal ID for a state.
                                                                               371
Lowercase alphanumeric and underscores are allowed.",
      "type": "string",
                                                                               373
      "pattern": "^state:[a-z0-9_]+$"
    },
                                                                               375
    "personID": {
                                                                               376
      "description": "String used as an internal ID for a person.
Lowercase alphanumeric and underscores are allowed.",
                                                                               378
      "type": "string",
                                                                               379
      "pattern": "^person:[a-z0-9_]+$"
                                                                               380
    "organizationID": {
                                                                               382
      "description": "String used as an internal ID for an organization.
Lowercase alphanumeric and underscores are allowed.",
      "type": "string",
      "pattern": "^organization:[a-z0-9_]+$"
                                                                               386
    },
    "serviceID": {
      "description": "String used as an internal ID for a service.
Lowercase alphanumeric and underscores are allowed.",
                                                                               390
      "type": "string",
                                                                               391
      "pattern": "^service:[a-z0-9_]+$"
    },
                                                                               393
    "statementID": {
      "description": "String used as an internal ID for a statement.
                                                                               395
Lowercase alphanumeric and underscores are allowed.",
      "type": "string",
                                                                               397
      "pattern": "^statement:[a-z0-9_]+$"
    },
    "userRequirementID": {
      "description": "String used as an internal ID for a user
                                                                               401
requirement. Lowercase alphanumeric and underscores are allowed.",
      "type": "string",
                                                                               403
      "pattern": "^requirement:[a-z0-9_]+$"
    },
                                                                               405
    "mediaID": {
      "description": "String used as an internal ID for a media element.
Lowercase alphanumeric and underscores are allowed.",
      "type": "string",
                                                                               409
      "pattern": "^media:[a-z0-9_]+$"
                                                                               410
```

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```
},
                                                                                  411
    "mediaFile": {
                                                                                  412
      "type": "object",
                                                                                  413
      "properties": {
                                                                                  414
        "title": {
                                                                                  415
           "description": "The title of the media file.",
                                                                                  416
           "$ref": "#/definitions/localizedString"
                                                                                  417
        },
        "url": {
                                                                                  419
           "description": "The reference to the media file (url or
                                                                                  420
resource).",
                                                                                  421
           "$ref": "#/definitions/url"
        },
                                                                                  423
        "file": {
           "description": "The actual media file (base64 or svg) as a
data URI scheme.",
           "oneOf": [
                                                                                  427
             {
                                                                                  428
               "type": "string",
               "pattern": "^data:([a-z0-9/]+);base64,([a-zA-Z0-9+/=]+)$"
                                                                                  430
                                                                                  431
                                                                                  432
               "type": "string",
               "pattern": "^data:image/svg\+xml;utf8,(.*)$"
                                                                                  434
             }
          ]
                                                                                  436
        },
                                                                                  437
        "width": {
                                                                                  438
          "description": "The number of pixels horizontally (if a bitmap
image or video).",
           "type": "integer"
        },
                                                                                  442
        "height": {
                                                                                  443
           "description": "The number of pixels vertically (if a bitmap
image or video).",
                                                                                  445
           "type": "integer"
                                                                                  446
        },
                                                                                  447
        "length": {
           "description": "The length in seconds of an audio or video
                                                                                  449
file.",
                                                                                  450
          "type": "integer"
                                                                                  451
        },
         "placeholder": {
                                                                                  453
           "description": "Image file that can be shown instead of the
                                                                                  454
video or audio file.",
           "$ref": "#/definitions/mediaID"
        },
                                                                                  457
        "creator": {
           "description": "The id(s) of the creator(s) of the media
file",
                                                                                  460
           "oneOf": [
                                                                                  461
             {
                                                                                  462
```

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```
"$ref": "#/definitions/personID"
                                                                                     463
             },
                                                                                     464
                                                                                     465
                "type": "array",
                "items": {
                                                                                     467
                  "$ref": "#/definitions/personID"
                                                                                     468
                                                                                     469
             }
           ]
                                                                                     471
         },
                                                                                     472
         "contributor": {
                                                                                     473
           "description": "The id(s) of the contributor(s) of the media
file",
                                                                                     475
           "oneOf": [
                                                                                     476
             {
                                                                                     477
                "$ref": "#/definitions/personID"
                                                                                     478
             },
                                                                                     479
                                                                                     480
                "type": "array",
                "items": {
                                                                                     482
                  "$ref": "#/definitions/personID"
                                                                                     483
                                                                                     484
             }
           ]
                                                                                     486
         },
         "publisher": {
           "description": "The id(s) of the publishing institutions of
the media file.",
                                                                                     490
           "oneOf": [
                                                                                     492
                "$ref": "#/definitions/organizationID"
             },
                                                                                     494
             {
                                                                                     495
                "type": "array",
                "items": {
                                                                                     497
                  "$ref": "#/definitions/organizationID"
                                                                                     498
                                                                                     499
             }
           ]
                                                                                     501
         },
                                                                                     503
           "description": "The url to the license under which the media
file falls.",
                                                                                     505
           "$ref": "#/definitions/url",
                                                                                     506
           "examples": [
                                                                                     507
              "https://creativecommons.org/licenses/by/4.0/"
                                                                                     509
         }
                                                                                     510
      },
                                                                                     511
       "additionalProperties": false
                                                                                     512
                                                                                     513
    "mediaElement": {
                                                                                     514
```

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```
"description": "A media element (collection of various formats of
                                                                                    515
the same media object).",
                                                                                    516
      "type": "object",
                                                                                    517
      "properties": {
                                                                                    518
         "file": {
                                                                                    519
           "description": "The various formats of the same media
                                                                                    520
object.",
                                                                                    521
           "oneOf": [
             {
                                                                                    523
                "$ref": "#/definitions/mediaFile"
                                                                                    524
             },
                                                                                    525
             {
                "type": "array",
                                                                                    527
                "items": {
                  "$ref": "#/definitions/mediaFile"
                                                                                    529
                                                                                    530
             }
                                                                                    531
           1
                                                                                    532
        }
                                                                                    533
      },
                                                                                    534
      "additionalProperties": false
                                                                                    535
    },
                                                                                    536
    "multiPolygon": {
       "description": "The coordinates array of a GeoJSON
                                                                                    538
MultiPolygon.",
      "type": "array",
                                                                                    540
      "items": {
                                                                                    541
         "type": "array",
                                                                                    542
         "items": {
           "type": "array",
                                                                                    544
           "items": {
             "type": "array",
                                                                                    546
             "items": {
                                                                                    547
                "type": "number"
                                                                                    548
                                                                                    549
           }
                                                                                    550
        }
                                                                                    551
      }
    },
                                                                                    553
    "geography": {
      "description": "A geographic element (name, polygon, and/or
                                                                                    555
external service).",
      "type": "object",
                                                                                    557
      "properties": {
                                                                                    558
         "name": {
                                                                                    559
           "description": "The name of the area(s).",
           "comment": "Accepts array for multilingual support.",
                                                                                    561
           "$ref": "#/definitions/localizedString",
           "examples": [
                                                                                    563
             "Norway",
             "Europe",
                                                                                    565
             "Trøndelag",
                                                                                    566
```

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```
567
               "Norge",
                                                                                  568
               "Norway"
                                                                                  569
             ]
          ]
                                                                                  571
        },
                                                                                  572
        "polygon": {
                                                                                  573
           "description": "The geographical area(s), represented as the
coordinates array of a GeoJSON MultiPolygon.",
                                                                                  575
           "$ref": "#/definitions/multiPolygon"
        },
                                                                                  577
        "service": {
           "description": "An url or external service that returns
                                                                                  579
geographical information.",
          "$ref": "#/definitions/url"
                                                                                  581
        }
      },
                                                                                  583
      "additionalProperties": false
                                                                                  584
    },
    "externalResource": {
                                                                                  586
      "description": "A resource managed elsewhere.",
                                                                                  587
      "type": "object",
                                                                                  588
      "properties": {
        "serviceId": {
                                                                                  590
           "description": "The id to one of the externalServices
defined.",
                                                                                  592
           "$ref": "#/definitions/serviceID"
                                                                                  593
        },
                                                                                  594
        "externalId": {
           "description": "The id of the resource at the
                                                                                  596
externalService.",
           "type": "string"
                                                                                  598
        }
                                                                                  599
      },
      "additionalProperties": false
                                                                                  601
    },
                                                                                  602
    "externalService": {
                                                                                  603
      "description": "Service used by the key, for media files, taxonomy
and/or nomenclature, species distributions, etc.",
                                                                                  605
      "type": "object",
      "required": [
                                                                                  607
        "id"
      ],
                                                                                  609
      "properties": {
                                                                                  610
        "id": {
                                                                                  611
           "description": "Internally unique id to the service.",
           "$ref": "#/definitions/serviceID"
                                                                                  613
        },
                                                                                  614
        "title": {
                                                                                  615
           "description": "Name of the service.",
                                                                                  616
           "type": "string"
                                                                                  617
        },
                                                                                  618
```

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```
"description": {
                                                                                  619
           "description": "Description of the service.",
                                                                                  620
           "type": "string"
                                                                                  621
        },
         "provider": {
                                                                                  623
           "description": "Provider of the service.",
                                                                                  624
           "type": "string"
                                                                                  625
        },
         "url": {
                                                                                  627
           "description": "Url for the service documentation.",
           "$ref": "#/definitions/url"
        }
      },
                                                                                  631
      "additionalProperties": false
                                                                                  632
    },
                                                                                  633
    "person": {
                                                                                  634
      "type": "object",
                                                                                  635
      "required": [
                                                                                  636
         "id".
         "name"
                                                                                  638
      ],
                                                                                  639
      "properties": {
                                                                                  640
         "id": {
           "$ref": "#/definitions/personID"
                                                                                  642
        },
         "name": {
                                                                                  644
           "description": "Full name of the person",
           "comment": "Accepts object for multilingual support.",
                                                                                  646
           "$ref": "#/definitions/localizedString"
        },
                                                                                  648
         "email": {
           "description": "Email address of the person",
                                                                                  650
           "type": "string",
                                                                                  651
           "format": "email"
                                                                                  652
        },
                                                                                  653
         "url": {
           "description": "Hyperlink to more information on the person
                                                                                  655
(valid url).",
           "comment": "Accepts object for multilingual support.",
                                                                                  657
           "$ref": "#/definitions/localizedUrl"
        },
                                                                                  659
         "media": {
           "description": "A media file (image) representing the
                                                                                  661
person.",
                                                                                  662
           "$ref": "#/definitions/mediaID"
        },
         "affiliation": {
                                                                                  665
           "description": "Organization id(s) the person is affiliated
with.",
           "oneOf": [
             {
                                                                                  669
               "$ref": "#/definitions/organizationID"
                                                                                  670
```

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```
},
                                                                                   671
                                                                                   672
               "type": "array",
                                                                                   673
               "items": {
                                                                                   674
                  "$ref": "#/definitions/organizationID"
                                                                                   675
                                                                                   676
             }
                                                                                   677
           ]
        }
                                                                                   679
      },
      "additionalProperties": false
                                                                                   681
    },
    "organization": {
                                                                                   683
      "type": "object",
      "required": [
                                                                                   685
        "id",
         "name"
                                                                                   687
      ],
                                                                                   688
      "properties": {
         "id": {
                                                                                   690
           "$ref": "#/definitions/organizationID"
                                                                                   691
        },
                                                                                   692
         "name": {
           "description": "Name of the organization",
                                                                                   694
           "comment": "Accepts object for multilingual support.",
           "$ref": "#/definitions/localizedString"
        },
         "url": {
                                                                                   698
           "description": "Hyperlink to more information on the
organization (valid url).",
                                                                                   700
           "comment": "Accepts object for multilingual support.",
           "$ref": "#/definitions/localizedUrl"
                                                                                   702
        },
                                                                                   703
         "primaryContact": {
           "description": "The person-id that is the main contact point
                                                                                   705
for the organization.",
                                                                                   706
           "$ref": "#/definitions/personID"
                                                                                   707
        },
         "media": \{
                                                                                   709
           "description": "A media file (image) representing the
organization, such as a logo.",
                                                                                   711
           "$ref": "#/definitions/mediaID"
        }
                                                                                   713
      },
                                                                                   714
      "additionalProperties": false
                                                                                   715
    },
    "userRequirement": {
                                                                                   717
      "type": "object",
      "required": [
                                                                                   719
         "id"
      ],
                                                                                   721
      "properties": {
                                                                                   722
```

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```
"id": {
                                                                                723
           "$ref": "#/definitions/userRequirementID"
                                                                                724
        },
                                                                                725
        "title": {
           "comment": "Accepts array for multilingual support.",
                                                                                727
          "$ref": "#/definitions/localizedString"
        },
                                                                                729
        "warning": {
           "comment": "Accepts array for multilingual support.",
                                                                                731
          "$ref": "#/definitions/localizedString"
                                                                                732
        },
                                                                                733
        "description": {
           "description": "Short description of the requirements to the
                                                                                735
user (valid markdown).",
           "comment": "Accepts object for multilingual support.",
                                                                                737
           "$ref": "#/definitions/localizedString",
           "contentMediaType": "text/markdown"
                                                                                739
        },
                                                                                740
        "descriptionDetails": {
           "description": "Extended description of the requirements to
                                                                                742
the user that supplements the description (valid markdown).",
                                                                                743
           "comment": "Accepts object for multilingual support.",
                                                                                744
           "$ref": "#/definitions/localizedString",
           "contentMediaType": "text/markdown"
                                                                                746
        },
        "descriptionUrl": {
                                                                                748
           "description": "Hyperlink to more information on the
requirements to the user (valid url).",
                                                                                750
          "comment": "Accepts object for multilingual support.",
           "$ref": "#/definitions/localizedUrl"
                                                                                752
        },
        "media": {
                                                                                754
           "description": "Media or illustration that informs the user on
the requirements to the user.",
          "comment": "Accepts object for multilingual support.",
                                                                                757
           "$ref": "#/definitions/mediaID"
                                                                                758
        }
                                                                                759
      },
      "additionalProperties": false
                                                                                761
    },
    "taxon": {
                                                                                763
      "type": "object",
      "oneOf": [
                                                                                765
                                                                                766
           "required": [
             "id",
             "scientificName"
                                                                                769
          1
        },
                                                                                771
           "required": [
                                                                                773
             "id",
```

774

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```
"externalReference"
                                                                                  775
          ٦
                                                                                  776
        },
                                                                                  777
        {
           "required": [
                                                                                  779
             "id",
             "label"
                                                                                  781
          ]
        }
                                                                                  783
      ],
      "properties": {
        "id": {
           "description": "Internally unique id to the taxon.",
                                                                                  787
           "$ref": "#/definitions/taxonID"
        },
        "scientificName": {
           "description": "Scientific name of the taxon.",
                                                                                  791
           "minLength": 5,
                                                                                  792
           "type": "string",
           "examples": [
                                                                                  794
             "Vulpes lagopus"
                                                                                  795
          ]
                                                                                  796
        },
        "scientificNameAuthor": {
           "description": "Author string of the scientific name of the
taxon.",
           "type": "string",
           "examples": [
                                                                                  802
             "Koch, 1888"
                                                                                  804
        },
        "placeholderName": {
                                                                                  806
           "description": "Name that can be shown while fetching the name
externally. Also useful for editing the key.",
                                                                                  808
           "comment": "Accepts object for multilingual support.",
                                                                                  809
          "$ref": "#/definitions/localizedString",
                                                                                  810
           "examples": [
                                                                                  811
             "B. hortorum (melanistic queen)"
                                                                                  812
          ]
                                                                                  813
        },
                                                                                  814
        "vernacularName": {
                                                                                  815
           "description": "Vernacular name of the taxon.",
           "comment": "Accepts object for multilingual support.",
                                                                                  817
           "$ref": "#/definitions/localizedString",
                                                                                  818
           "examples": [
                                                                                  819
             "fjellrev",
                                                                                  821
               "no": "fjellrev",
               "en": "Arctic Fox"
                                                                                  823
             }
          ]
                                                                                  825
        },
                                                                                  826
```

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```
"media": {
                                                                                 827
           "description": "Media elements of the taxon.",
                                                                                 828
           "oneOf": [
                                                                                 829
             {
               "$ref": "#/definitions/mediaID"
                                                                                 831
             },
                                                                                 832
                                                                                 833
               "type": "array",
               "items": {
                                                                                 835
                 "$ref": "#/definitions/mediaID"
                                                                                 837
             }
          ]
                                                                                 839
        },
        "description": {
                                                                                 841
           "description": "Short description of the taxon (valid
markdown).",
                                                                                 843
           "comment": "Accepts object for multilingual support.",
                                                                                 844
          "$ref": "#/definitions/localizedString",
          "contentMediaType": "text/markdown"
                                                                                 846
        },
                                                                                 847
        "descriptionDetails": {
                                                                                 848
           "description": "Extended description of the taxon that
supplements the description (valid markdown).",
                                                                                 850
           "comment": "Accepts object for multilingual support.",
           "$ref": "#/definitions/localizedString",
                                                                                 852
          "contentMediaType": "text/markdown"
        },
                                                                                 854
        "descriptionUrl": {
           "description": "Hyperlink or resource to more information on
                                                                                 856
the taxon.",
           "comment": "Accepts object for multilingual support.",
                                                                                 858
          "$ref": "#/definitions/localizedUrl"
                                                                                 859
        },
                                                                                 860
        "rank": {
                                                                                 861
           "description": "Name of the level of the taxon.",
                                                                                 862
           "comment": "Accepts object for multilingual support.",
                                                                                 863
           "$ref": "#/definitions/localizedString",
           "examples": [
                                                                                 865
             "slekt",
                                                                                 867
               "no": "slekt",
               "en": "genus"
                                                                                 869
             }
          ]
                                                                                 871
        },
        "label": {
                                                                                 873
           "description": "Type of morph of the taxon.",
           "type": "string",
                                                                                 875
           "minLength": 0,
           "examples": [
                                                                                 877
```

878

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"male",

```
"Ω",
                                                                                 879
             "larva"
                                                                                 880
          1
                                                                                 881
        },
        "isEndPoint": {
                                                                                 883
           "description": "Whether the key should stop when this taxon is
the only remaining possibility, even when it has multiple children
                                                                                 885
remaining.",
           "comment": "Default is FALSE (if not specified). A taxon
                                                                                 887
without children is alway an endpoint by definition, unless one of its
ancestors overrides this by being specified as an endpoint.",
           "type": "boolean"
        },
                                                                                 891
        "children": {
          "type": "array",
                                                                                 893
           "items": {
                                                                                 894
             "$ref": "#/definitions/taxon"
                                                                                 895
          }
                                                                                 896
        },
        "externalReference": {
                                                                                 898
           "description": "Reference to a taxon at one or more providers,
                                                                                 899
each as an object with a provider id and a taxon id at that provider.",
                                                                                 900
           "comment": "Accepts an array for multiple sources. Each
element accepts an object for multilingual support.",
                                                                                 902
           "oneOf": [
             {
                                                                                 904
               "$ref": "#/definitions/localizedUrl"
                                                                                 905
             },
                                                                                 906
               "type": "array",
                                                                                 908
               "items": {
                 "$ref": "#/definitions/localizedUrl"
                                                                                 910
                                                                                 911
            }
                                                                                 912
          ]
                                                                                 913
        },
                                                                                 914
        "followUp": {
                                                                                 915
           "description": "Url or reference to instance at external
service for a key for this taxon, that for instance can be used to
                                                                                 917
identify to a lower rank than the current key can.",
           "comment": "Accepts array for multilingual support.",
                                                                                 919
           "$ref": "#/definitions/localizedUrl"
        },
                                                                                 921
        "geography": {
                                                                                 922
           "description": "The area(s) in which the taxon occurs,
                                                                                 923
represented as a geography object.",
           "$ref": "#/definitions/geography"
                                                                                 925
        }
      },
                                                                                 927
      "additionalProperties": false
    },
                                                                                 929
    "character": {
                                                                                 930
```

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```
"type": "object",
                                                                                 931
      "required": [
                                                                                 932
        "id",
                                                                                 933
        "title"
        "states"
                                                                                 935
      ],
      "properties": {
                                                                                 937
        "id": {
           "description": "Internally unique id to the character.",
                                                                                 939
          "$ref": "#/definitions/characterID"
        },
                                                                                 941
        "title": {
           "description": "Name of the character.",
                                                                                 943
          "comment": "Accepts array for multilingual support.",
          "$ref": "#/definitions/localizedString",
                                                                                 945
           "examples": [
             "Color of the wings"
                                                                                 947
          1
                                                                                 948
        },
        "media": {
                                                                                 950
           "description": "The media element(s) of the character. Can be
                                                                                 951
used to inform user of relevant structures etc.",
                                                                                 952
           "oneOf": [
             {
                                                                                 954
               "$ref": "#/definitions/mediaID"
            },
                                                                                 956
                                                                                 957
               "type": "array",
                                                                                 958
               "items": {
                 "$ref": "#/definitions/mediaID"
                                                                                 960
             }
                                                                                 962
          ]
                                                                                 963
        },
        "description": {
                                                                                 965
           "description": "Short description of the character (valid
markdown).",
                                                                                 967
           "comment": "Accepts object for multilingual support.",
           "$ref": "#/definitions/localizedString",
                                                                                 969
          "contentMediaType": "text/markdown"
        },
                                                                                 971
        "descriptionDetails": {
           "description": "Extended description of the character that
                                                                                 973
supplements the description (valid markdown).",
           "comment": "Accepts object for multilingual support.",
                                                                                 975
           "$ref": "#/definitions/localizedString",
           "contentMediaType": "text/markdown"
                                                                                 977
        },
        "descriptionUrl": {
                                                                                 979
           "description": "Hyperlink or resource to more information on
the character.",
                                                                                 981
           "comment": "Accepts object for multilingual support.",
                                                                                 982
```

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```
"$ref": "#/definitions/localizedUrl"
                                                                                   983
        },
                                                                                   984
         "type": {
                                                                                   985
           "description": "Type of the character (exclusive when states
are categorical and mutually exclusive, non-exclusive when these are
                                                                                   987
non-exclusive, or numerical when the state is numerical).",
           "comment": "Default is exclusive (if not specified).",
                                                                                   989
           "type": "string",
           "enum": [
                                                                                   991
             "exclusive",
                                                                                   992
             "non-exclusive",
                                                                                   993
             "numerical"
           1
                                                                                   995
        },
         "userRequirement": {
                                                                                   997
           "description": "Id to the userRequirement required to answer
this character.",
                                                                                   aga
           "comment": "Has to be one of the userRequirement defined on
                                                                                   1000
the key level.",
                                                                                   1001
           "$ref": "#/definitions/userRequirementID"
                                                                                   1002
        },
                                                                                   1003
         "logicalPremise": {
                                                                                   1004
           "description": "Logical requirement that has to be fulfilled
for this question to be asked.",
                                                                                   1006
           "comment": "Has to refer to stateIds, that have to be fully
true (either answered or all alternatives ruled out). Can use !, &&, ||,
                                                                                   1008
(, ), <, >, =.",
                                                                                   1009
           "type": "string",
                                                                                   1010
           "pattern": "^(( && )|( \|\|
                                                                                   1011
|(\&\&)|(\|\|)|[a-z0-9_:()!<>=])+$"
                                                                                   1012
        },
                                                                                   1013
         "states": {
                                                                                   1014
           "oneOf": [
                                                                                   1015
             {
                                                                                   1016
               "type": "array",
                                                                                   1017
               "items": {
                                                                                   1018
                  "$ref": "#/definitions/state"
                                                                                   1019
               }
                                                                                   1020
             },
                                                                                   1021
             {
                                                                                   1022
               "$ref": "#/definitions/state"
                                                                                   1023
             }
                                                                                   1025
        }
                                                                                   1026
      },
                                                                                   1027
      "additionalProperties": false
    },
                                                                                   1029
    "state": {
                                                                                   1030
      "description": "The value a character can have.",
                                                                                   1031
      "type": "object",
                                                                                   1032
      "oneOf": [
                                                                                   1033
         {
                                                                                   1034
```

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```
"required": [
                                                                                      1035
              "id",
                                                                                      1036
              "title"
                                                                                      1037
           ]
                                                                                      1038
         },
                                                                                      1039
                                                                                      1040
           "required": [
                                                                                      1041
              "id",
              "min"
                                                                                      1043
              "max",
                                                                                      1044
              "stepSize",
                                                                                      1045
              "unit"
                                                                                      1047
         }
                                                                                      1048
      ],
                                                                                      1049
       "properties": {
                                                                                      1050
         "id": {
                                                                                      1051
           "description": "Internally unique id of the state.",
                                                                                      1052
           "$ref": "#/definitions/stateID"
                                                                                      1053
         },
                                                                                      1054
         "title": {
                                                                                      1055
           "description": "Content of the state.",
                                                                                      1056
           "comment": "Only to be used for categorical characters.
Accepts object for multilingual support.",
                                                                                      1058
           "$ref": "#/definitions/localizedString"
                                                                                      1059
         },
                                                                                      1060
         "media": {
                                                                                      1061
           "description": "Media element(s) that illustrate the state.",
                                                                                      1062
           "oneOf": [
                                                                                      1063
              {
                                                                                      1064
                "$ref": "#/definitions/mediaID"
                                                                                      1065
             },
                                                                                      1066
              {
                                                                                      1067
                "type": "array",
                                                                                      1068
                "items": {
                                                                                      1069
                  "$ref": "#/definitions/mediaID"
                                                                                      1070
                                                                                      1071
             }
                                                                                      1072
           ]
                                                                                      1073
         },
                                                                                      1074
         "description": {
                                                                                      1075
           "description": "Short description of the state (valid
markdown).",
                                                                                      1077
           "comment": "Accepts object for multilingual support.",
                                                                                      1078
           "$ref": "#/definitions/localizedString",
                                                                                      1079
           "contentMediaType": "text/markdown"
         },
                                                                                      1081
         "descriptionDetails": {
                                                                                      1082
           "description": "Extended description of the state that
                                                                                      1083
supplements the description (valid markdown).",
                                                                                      1084
           "comment": "Accepts object for multilingual support.",
                                                                                      1085
```

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"\$ref": "#/definitions/localizedString",

1086

```
"contentMediaType": "text/markdown"
                                                                                   1087
        },
                                                                                   1088
         "descriptionUrl": {
                                                                                   1089
           "description": "Hyperlink or resource to more information on
                                                                                   1090
the state.",
                                                                                   1091
           "comment": "Accepts object for multilingual support.",
           "$ref": "#/definitions/localizedUrl"
                                                                                   1093
        },
         "min": {
                                                                                   1095
           "description": "Lowest numerical value of the state (over all
                                                                                   1096
taxa).",
                                                                                   1097
           "comment": "Only to be used for numerical characters",
           "type": "number"
                                                                                   1099
        },
                                                                                   1100
         "max": {
                                                                                   1101
           "description": "Highest possible numerical value of the state
                                                                                   1102
(over all taxa).",
                                                                                   1103
           "comment": "Only to be used for numerical characters",
                                                                                   1104
           "type": "number"
                                                                                   1105
        },
                                                                                   1106
         "stepSize": {
                                                                                   1107
           "description": "Step size of the state (steps between min and
                                                                                   1108
max, over all taxa).",
           "comment": "Only to be used for numerical characters",
                                                                                   1110
           "type": "number"
                                                                                   1111
        },
                                                                                   1112
         "unit": {
                                                                                   1113
           "description": "Unit in which the state is measured or
                                                                                   1114
counted.",
           "comment": "Only to be used for numerical characters. Accepts
                                                                                   1116
object for multilingual support.",
           "$ref": "#/definitions/localizedString",
                                                                                   1118
           "examples": [
                                                                                   1119
             "mm",
                                                                                   1120
             "meters below the surface",
                                                                                   1121
             "spots",
                                                                                   1122
             "legs",
                                                                                   1123
             "kg"
                                                                                   1124
                                                                                   1125
        }
      },
                                                                                   1127
      "additionalProperties": false
    },
                                                                                   1129
    "statement": {
                                                                                   1130
      "description": "A fact connecting a taxon and a character through
                                                                                   1131
a certain value.",
      "type": "object",
                                                                                   1133
      "required": [
                                                                                   1134
         "id",
                                                                                   1135
         "taxon",
                                                                                   1136
         "character",
                                                                                   1137
         "value",
                                                                                   1138
```

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```
"frequency"
                                                                                    1139
      ],
                                                                                    1140
       "properties": {
                                                                                    1141
         "id": {
                                                                                    1142
           "description": "Internally unique id of the statement.",
                                                                                    1143
           "$ref": "#/definitions/statementID"
                                                                                    1144
         },
                                                                                    1145
         "taxon": {
           "description": "Id of the taxon this statement is about.",
                                                                                    1147
           "$ref": "#/definitions/taxonID"
                                                                                    1148
         },
                                                                                    1149
         "character": {
           "description": "Id of the character this statement is
                                                                                    1151
about.",
                                                                                    1152
           "$ref": "#/definitions/characterID"
                                                                                    1153
         },
                                                                                    1154
         "value": {
                                                                                    1155
           "description": "A value for this character for this taxon.
                                                                                    1156
Must be either the id of a state, or an array of floats [min, max] for a
numerical range.",
                                                                                    1158
           "oneOf": [
                                                                                    1159
                                                                                    1160
                "$ref": "#/definitions/stateID"
             },
                                                                                    1162
                                                                                    1163
                "type": "array",
                                                                                    1164
                "items": {
                                                                                    1165
                  "type": "number"
                                                                                    1166
                },
                                                                                    1167
                "minItems": 2.
                                                                                    1168
                "maxItems": 2
                                                                                    1169
                                                                                    1170
           ]
                                                                                    1171
         },
                                                                                    1172
         "frequency": {
                                                                                    1173
           "description": "The frequency with which the taxon has this
                                                                                    1174
value for this character.",
                                                                                    1175
           "type": "number",
                                                                                    1176
           "minimum": 0,
                                                                                    1177
           "maximum": 1
                                                                                    1178
         },
                                                                                    1179
         "geography": {
           "description": "The area(s) in which the taxon can have this
                                                                                    1181
property, represented as a geography object.",
                                                                                    1182
           "$ref": "#/definitions/geography"
                                                                                    1183
         },
         "media": {
                                                                                    1185
           "description": "Illustration(s) of this particular taxon
                                                                                    1186
having this particular property (this value for this character).",
                                                                                    1187
           "oneOf": [
                                                                                    1188
                                                                                    1189
                "$ref": "#/definitions/mediaID"
                                                                                    1190
```

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```
},
                                                                                  1191
                                                                                  1192
                "type": "array",
                                                                                  1193
                "items": {
                  "$ref": "#/definitions/mediaID"
                                                                                  1195
               }
             }
                                                                                  1197
           ]
         },
                                                                                  1199
         "description": {
                                                                                  1200
           "description": "Short description of the taxon having this
                                                                                  1201
property (valid markdown).",
           "comment": "Accepts array for multilingual support.",
                                                                                  1203
           "$ref": "#/definitions/localizedString",
                                                                                  1204
           "contentMediaType": "text/markdown"
                                                                                  1205
         },
                                                                                  1206
         "descriptionDetails": {
                                                                                  1207
           "description": "Extended description of the taxon having this
                                                                                  1208
property that supplements the description (valid markdown).",
                                                                                  1209
           "comment": "Accepts array for multilingual support.",
                                                                                  1210
           "$ref": "#/definitions/localizedString",
                                                                                  1211
           "contentMediaType": "text/markdown"
                                                                                  1212
         },
         "descriptionUrl": {
                                                                                  1214
           "description": "Hyperlink or resource to more information on
the taxon having this property.",
                                                                                  1216
           "comment": "Accepts array for multilingual support.",
                                                                                  1217
           "$ref": "#/definitions/localizedUrl"
                                                                                  1218
         }
      },
                                                                                  1220
       "additionalProperties": false
    }
                                                                                  1222
  }
                                                                                  1223
}
                                                                                  1224
```

1225

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