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Glasgow Museums Biological Records Centre: achievements over the past 25 years and future prospects

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ABSTRACT

The development of Glasgow Museums Biological Records Centre from its inception in 1997 to the present is described, along with geographical and taxonomic coverage of the records. The principal sources of records are listed, and the contribution of online recording systems in recent years is highlighted. Data accuracy, gaps in taxonomic coverage, and new taxa possibly resulting from climate change are discussed. Finally, the possible future of the Centre in the context of the Scottish Better Biodiversity Data project is outlined.

INTRODUCTION

There has long been a close association between Glasgow Natural History Society (GNHS) and Glasgow Life Museums. The Society was instrumental in donating specimens and setting up the early natural history displays in Kelvingrove House, the predecessor of Kelvingrove Art Gallery and Museum (Sutcliffe, 2016). In an earlier paper (Weddle, 2001), we described the history of biological recording in the Clyde area, up to the establishment for the first time of an electronic biological records database for Glasgow Museums Biological Records Centre (GMBRC). This database, run using Recorder 3 software on a desktop computer housed in the basement of Kelvingrove Museum, was begun in the summer of 1997 with the help of six temporary assistants. It had reached about 115,000 records by the time the 2001 paper was written and has now been in existence for over 25 years (Fig. 1). As the database has recently passed the million-records milestone it seems an appropriate time to review what has been achieved by this GNHS/Glasgow Life Museums collaboration, and to consider what the future might hold for GMBRC.

OVERVIEW OF GMBRC'S RECORDER DATABASE

Data Software

The original Recorder 3 system, developed by Stuart Ball of the Joint Nature Conservation Committee, ran on the Microsoft DOS operating system. This was the system used when the GMBRC started in 1997, but the records were exported from there to the new Microsoft Windows application using a Microsoft (MS) Access database known as Recorder 2000/2002, which was subsequently developed as Recorder 6 on the MS SQL Server platform.

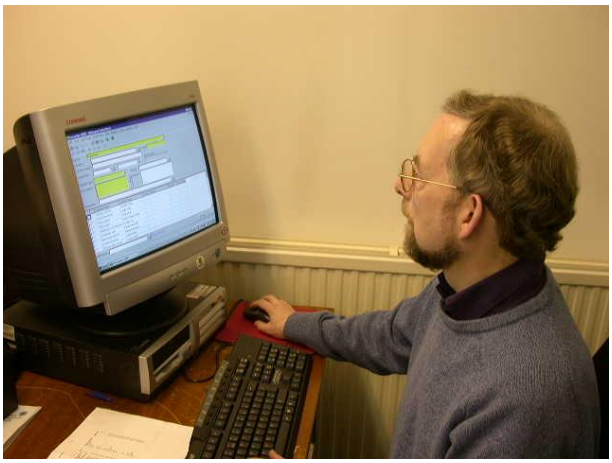

Fig. 1. Richard Weddle at the GMBRC desktop PC after it moved from Kelvingrove Museum to Glasgow Museums Resource Centre, Nitshill, *ca.* 2008. (Photo: R. Sutcliffe)

The core species list is based on the U.K. Species Inventory (UKSI) maintained by the Natural History Museum, London. There is a sophisticated internal cross-referencing system which relates older taxon names and synonyms to "preferred names". It can also report older taxon names as taxon aggregates where there has been historical confusion or where the taxon has been shown to include new species. For instance, records of the harvestman *Dicranopalpus ramosus*, are reported as *ramosus sensu lato,* except where a post-2015 key has been used to identify them and they have been explicitly input as *ramosus sensu stricto*. The rather similar *D. caudatus*, previously thought to be synonymous with *D. ramosus*, was confirmed as present in the U.K. in 2015.

Data Sources

Many of the historical sources of records were described in Weddle (2001). Up to that time GMBRC prioritised data that fell within the 1996 city boundary or close by, mainly because of the launch of the first Glasgow Local Biodiversity Plan (LBP) in that year (Glasgow City Council, 2001), which included extensive lists of species known to exist, or thought to exist, within the City boundary. This "Glasgow Species Audit" has been updated several times since then. An extract, consisting of the species listed in the most recent audit along with the number of records and the earliest and latest years (where known), is available online (GNHS, 2023).

In the subsequent years we gradually added the missing historical records for the rest of the Clyde area and have also included records from outwith that area where they formed part of a significant dataset. This includes museum specimens collected by locally significant naturalists, and in some cases data from their field notebooks. The most significant additions to the sources of data have been continuing efforts by individual naturalists, including downloads from the various online recording systems such as BirdTrack, iRecord and iNaturalist. These recording systems have themselves facilitated a significant increase in recording effort as part of general community science initiatives, such as those described by The Natural History Museum in London (NHM, 2023). At various times we have received data, often in exchange for updates from our records, with national recording schemes such as the Scottish Squirrel Survey and Scottish Badgers.
Further sources will be highlighted below, in the relevant context.

Data Services

Over the years GMBRC has provided: datasets in support of reviews of scarce and threatened species; records for environmental consultants in connection with proposed developments (housing, commercial, wind farms etc.); species lists for designated sites for Biodiversity Officers in the various Local Authorities in the area; species lists for the Biodiversity area of the GNHS website; records or species lists for academic purposes; and species lists for entire Local Authorities (species "audits").

Perhaps most importantly, we have uploaded over 19,000 records directly to the National Biodiversity Network (NBN). Many of these had been prepared as a response to enquiries, such as national reviews of particular taxon groups, though some datasets were submitted to flag up significant range expansions of some of the constituent species in the area. The uploaded datasets are listed in Table 1. Further details on these, together with other information including statistics showing why the data has been accessed, are available at NBN (2023). Many more GMBRC records have been submitted via U.K. recording schemes, such as the National Moth Recording Scheme, the Trichoptera (caddisfly) Scheme, and the British Dragonfly Society.

One of the most important functions of local environmental records centres is data verification: they have a local perspective on both the taxa which occur in the area, and the recorders who send in records. This process includes data reviews, for example a review of the historical amphibian and reptile records for *The Glasgow Naturalist* (McInerny, 2020) looked at many records that had been transcribed from publications by the national Biological Records Centre in the last quarter of the 20th century. The review highlighted a number of unlikely or unverifiable records, which were fed back to the current custodians of the records at the U.K. Centre for Ecology and Hydrology and the GMBRC database was amended appropriately.

CURRENT RECORDS

At the time of writing (8th November 2023) there are 1,038,646 records in GMBRC's database. Whereas the 2001 list included only Glasgow records, the database now covers a much larger area comprising mainly neighbouring local authorities in our "core area"' of west central Scotland, although there are also records from further afield. Table 2 indicates the coverage of the "core area" and some peripheral areas, but excludes remoter records. These remote records are typically records supplied by museum collections, and can be from as far away as East Malling in Kent.

For the former county of Renfrewshire, excluding the part within Glasgow, i.e. Renfrewshire, East Renfrewshire and Inverclyde, there are 309,577 records, 29.7% of the overall total. *The Flora of Renfrewshire* records form a significant part of this total as well as contributing to the Glasgow total (Watson, 2014). Many

Class/Order	Superfamily/Family
Diptera	Tephritoidea (picture-winged flies)
	Conopidae (thick-headed flies)
	Hippoboscidae ((louse flies, or keds)
	Nycteribiidae (bat flies)
Coleoptera	Carabidae (ground beetles)
	Chrysomelidae (leaf beetles)
	Coccinellidae (ladybirds)
	Byrrhidae (moss beetles)
	Clambidae (fringe-winged beetles)
	Dascillidae (orchid beetle)
	Phalacridae (shining flower beetles)
	Monotomidae (root beetles)
	Oedemeridae (false blister beetles)
	Silphidae (burying beetles)
Hemiptera (true bugs)	
Orthoptera (grasshoppers, crickets etc.)	
Mammalia (both terrestrial and marine)	
Angiospermae (flowering plants)	Orchidaceae

Table 1. Datasets uploaded by GMBRC to the National Biodiversity Network.

Local Authority	Records	%
City of Glasgow	257,255	24.7
Renfrewshire	182,666	17.5
South Lanarkshire	106,162	10.2
East Dunbartonshire	100,221	9.6
East Renfrewshire	69,290	6.7
Argyll and Bute (only VC99 is a core area)	65,395	6.3
Inverclyde	57,621	5.5
North Lanarkshire	57,393	5.5
South Ayrshire	53,321	5.1
West Dunbartonshire	43,813	4.2
Stirling	43,079	4.1
North Ayrshire	15,176	1.5
East Ayrshire	4,048	0.4

Table 2. Numbers and percentages of records in the GMBRC database by Local Authority (west central Scotland only). Core coverage areas of GMBRC are italicised.

of the North Ayrshire records pertain to the parts of Clyde Muirshiel Regional Park within that local authority. Similarly, many of the East Ayrshire records pertain to the western part of Whitelee Windfarm Country Park. In addition, many of the Ayrshire records pertain to specimens in the Hunterian and Glasgow Life Museums collections, and records gleaned from books and journals.

A table of the number of records within the taxon groupings used by Recorder 6 is given in the Appendix. This table is similar to that given in Weddle (2001), though some of the organismal categories are unavoidably different. However, the categories are a similar mix of phyla, classes and orders because of factors such as the desirability of separating out the various orders of insects. The first column in the table is the number of taxa in the UKSI. These numbers are in some cases rather larger than might be expected because UKSI includes many subspecies, varieties, forms and hybrids, as well as a number of vagrants and other unestablished non-native species. For example, the list gives the number of butterfly species as 129, whereas most sources quote 59 as the number of current native species. However, the larger number seems more appropriate in this context as the records in the database also include the extra subspecies etc., although in both cases nominate trinomials have been excluded (for example *Maniola jurtina jurtina* in the case of meadow brown butterfly).

The other columns in the Appendix are numbers of records for various date ranges: up to 2003, 2003 to 2012, 2013 to 2023, and the total number of records for that organismal group. The numbers show the recording effort across the years, but comparison with the 2001 table, which lists only records in the database up to that year, highlights the fact that many pre-2001 records have been added since then. These include the *Changing Flora of Glasgow*, many of the *Flora of Renfrewshire* records, records gleaned from the pages of journals including *The Glasgow Naturalist* and *Entomologist's Monthly Magazine*, and records, mainly of beetles, extracted from the field diaries of Roy Crowson. The later date-ranges largely indicate the amount of recording effort in the last 20 years, particularly since the recent advent of online recording systems.

A summary of the figures given in the Appendix, using rather coarser organismal categories, is shown in Table 3 and a further summary of the insect groups is shown in Table 4. These illustrate a marked increase in recording of the smaller groups and species that were previously rather under-recorded at the time of the 2001 paper. This is in part due to the efforts of recording groups that have been set up in the last 20 years, including: the Clyde Amphibian and Reptile Group, Clyde and Argyll Fungus Group (though many of their records are not yet included in the GMBRC database), Friends of Hamiltonhill Claypits Local Nature Reserve (LNR), Friends of Glasgow's LNRs, Friends of Havoc Meadow, and Renfrewshire Recording Group. Further significant contributions come from bioblitzes and similar recording events organised by RSPB's *Giving Nature a Home* team, Buglife and The Conservation Volunteers. There are also numerous Facebook groups dedicated to particular taxonomic interests.

The recording effort has been supported over the years by training local naturalists to identify taxa, particularly invertebrates. TCV's "Natural Talent" apprenticeships helped greatly in this respect as the apprentices shared their new-found expertise in short courses linked to field-recording events, as well as their own field-recording. There were similar training courses, of one or two days, held at Glasgow Museums Resource Centre and the Hunterian Museum of the University of Glasgow as well as other venues such as community halls. Here the instructors were curators of those museums or visitors from national schemes such as the Hoverfly Recording Scheme or the Conchological Society of Great Britain and Ireland. Butterfly Conservation staff and volunteers have also contributed training events in the field at various parks and other local conservation sites.

However, there remain some under-recorded groups. The Ichneumonidae is a challenging group but many of the larger species can be identified from detailed photographs by experts who monitor the online

Group	Records added Pre-2003	Records added 2003-2012	Records added 2013-present	All records
Micro-organisms	51	36	253	340
Fungi	969	1,778	6,225	8,972
Lichens	662	197	222	1,081
Lower plants	5,527	507	1,020	7,054
Vascular plants	234,637	29,696	29,788	294,121
Arachnids	908	714	1,098	2,720
Insects	122,676	69,907	149,688	342,271
Other invertebrates	4,189	4,300	3,079	11,568
Lower chordates	-	3	-	3
Fish	303	199	63	565
Amphibians	1,505	2,108	1,698	5,311
Reptiles	849	124	129	1,102
Birds	33,874	30,886	285,796	350,556
Marine mammals	31	28	26	85
Terrestrial mammals	2,332	2,852	7,669	12,853
Grand Total	**408,513**	**143,335**	**486,754**	**1,038,602**

Table 3. The number of records for each organismal group in the GMBRC database.

Order	Records added pre-2003	Records added 2003-2012	Records added 2013-present	All Records
Silverfish (Thysanura)	4	3	3	10
Bristletails (Archaeognatha)	7	-	1	8
Mayflies (Ephemeroptera)	46	199	155	400
Dragonflies (Odonata)	5,891	1,570	932	8,393
Stoneflies (Plecoptera)	129	79	64	272
Grasshoppers etc. (Orthoptera)	194	51	85	330
Web-spinners (Embioptera)	-	-	-	-
Mantises (Mantodea)	-	-	-	-
Earwigs (Dermaptera)	41	33	76	150
Cockroaches (Dictyoptera)	39	1	4	44
Book/bark lice (Psocoptera)	67	10	20	97
Lice (Phthiraptera)	4	-	-	4
True bugs (Hemiptera)	1,474	605	1,556	3,635
Thrips (Thysanoptera)	5	2	3	10
Stick insects (Phasmida)	-	1	-	1
Snakeflies (Raphidioptera)	7	-	-	7
Alderflies (Megaloptera)	21	20	33	74
Lacewings (Neuroptera)	112	42	66	220
Beetles (Coleoptera)	25,003	2,051	4,804	31,858
Stylops (Strepsiptera)	2	-	-	2
Scorpion flies (Mecoptera)	30	33	45	108
Fleas (Siphonaptera)	33	19	1	53
Caddis flies (Trichoptera)	588	326	525	1,439
Butterflies (Lepidoptera)	15,484	26,115	41,450	83,049
Moths (Lepidoptera)	66,074	31,512	86,857	184,443
True flies (Diptera)	6,070	5,321	6,635	18,026
Bees, wasps etc. (Hymenoptera)	1,351	1,914	6,373	9,638
Grand Total	**122,676**	**69,907**	**149,688**	**342,271**

Table 4. The number of insect records for each Order in the GMBRC database.

recording systems. Many of the smaller plant bugs (e.g. Miridae, Nabidae, Cicadellidae, and Lygaeidae) are also relatively easily identified from detailed photographs, though there are currently few recorders who consider these groups. Most of the non-insect invertebrate groups, and all the micro-organisms listed in the Appendix, with the exception of the cyanobacteria ("blue-green algae"), seem to be largely neglected. In other taxonomic areas there are few active recorders, particularly in the younger age-range, of bryophytes and lichens.

Since 2009 GNHS and BRISC (Biological Recording in Scotland) have offered bursaries towards training courses such as those offered by the Field Studies Council. These have been open to all Scottish residents, and there has been a good take-up by those resident in the central belt of Scotland. Such training has been supplemented in recent years by online training courses, many of which were free or very reasonably priced. These were particularly numerous in the "COVID years" (2020-2022), but have continued since, and many were recorded and continue to be available.

The management of biological records has been further facilitated by the online recording systems mentioned above where the recorder can enter a record in the field and the geospatial coordinates are added automatically. In most cases the application can suggest a possible identification, using artificial intelligence (AI) methods, if a photograph has been submitted. There are, however, a number of actual and potential drawbacks with these systems for the inexperienced naturalist: the geospatial coordinates are of course those of the observer, who may be at some distance from the flora or fauna being reported; the suggestions for the identity of the taxon observed may be biased by the material that has been used for training the AI system – for example, iNaturalist often seems to favour North American species – and even when the recorder wishes to enter a species name manually, they can be presented with a confusing list of possibilities; and the databases used for describing the location can be unhelpful as they tend to be based on gazetteers of street names or electoral wards, and overlook LNRs and other sites of conservation interest. Despite these shortcomings, these systems have undeniably helped to increase the recording effort, particularly as they encourage newcomers by having a system of record verification when a suitable photograph has been provided.

Weddle (2001) mentioned a number of issues with identifying the location of observations. The problem with earlier records was typically their rather generalised locations, such as vice-county, town or parish, though the authors of some published lists devised their own system of subdividing the Clyde area, such as the botanical records in Scott Elliot *et al.* (1901), which was also adopted by Lee (1933). With the advent of the Ordnance Survey National Grid in 1947 it became standard practice to use a grid reference to indicate locations. In general, this was helpful, though it also gave rise to the practice of using the size of the grid square as an indication of the accuracy of the grid reference, which can be unhelpful or even misleading in a number of ways, particularly when the need is to link the record to a named site, such as a park or LNR, rather than simply producing a distribution map at vice-county or national level. The approach taken by the NBN Atlas is one defined by the "Darwin core" specification developed for the Atlas of Living Australia: locations, whether national grid references or latitude/longitude coordinates, are defined by a point with an associated "radius of uncertainty". This is a more scientifically rigorous approach, in that any measurement is always associated with an error that can be defined or at least estimated. When a global positioning system (GPS) is used to find the coordinates, the radius of uncertainty is given by the device used, For example a Garmin device shows an uncertainty reading alongside each spatial coordinate value, and systems such as iRecord and iNaturalist also record the uncertainty with the other geospatial information in their data stores.

This historical trend towards ever greater geospatial precision is now also driven by the increasing use of GIS (Geographic Information Systems) to relate species distributions to habitat maps, which in turn reflects the increasing awareness of the interconnectedness of the natural world, often described as the "web of life". The Recorder database system design includes the ability to link taxon records with habitat data and to specify the substrate, whether that be the tree on which a fungus was found, or a plant associated with an insect larva. In those examples the relationship is obvious, but there is undoubtedly a need for the less obvious inter-relationships to be investigated more fully, for example linking the sighting of a pollinating insect with the habitat requirements of the larval form of that insect.

Such topics also stress the inclusion of human life as part of this web. This encompasses on the one hand the part that the human economy plays in disturbing established ecosystems, and on the other the positive effects of the natural world on the health and well-being of individuals. However, those are aspects that are largely outside the realm of a biological records database, except to emphasise that recording environmental factors such as the conductivity, dissolved oxygen and pH of water bodies in connection with surveys of aquatic flora and fauna are as valuable as the taxon records themselves.

Climate change was not mentioned in the Weddle (2001) paper, but since then a number of previously unrecorded species have been found whose occurrence may indicate climatic change. There were a number of well-documented arrivals of butterfly species into the area prior to 2001 (Futter, 2006), and species such as the comma (*Polygonia c-album*), and the speckled wood (*Pararge aegeria*) in more recent years continue this trend (Fig. 2). Some moths, such as the narrow-bordered bee hawkmoth (*Hemaris tityus*) and the narrow-bordered five-spot burnet (*Zygaena lonicerae*), are now common in suitable habitats in and around Glasgow (GMBRC records). The recent sightings of water

Fig. 2. Speckled wood (*Pararge aegeria*), Holmhills Community Woodland LNR, South Lanarkshire, September 2023. (Photo: A. Park)

Fig. 3. Bee orchid (*Ophrys apifera*), Havoc, West Dumbartonshire, 2022. (Photo: S. Futter)

ladybird (*Anisosticta novemdecimpunctata*) in Glasgow and North Lanarkshire can probably be ascribed to climate change, particularly if it is present in water-bodies between here and the south of Dumfries and Galloway where it is long-established (Weddle, 2024a), though the recent proliferation of the harlequin ladybird (*Harmonia axyridis*) may well be part of a natural spread northwards. The recent occurrences of *Chorisops* soldierflies in Scotland (Weddle, 2024b), could also be a result of climate change. However, other factors may be at work: a number of new shield bug species (Pentatomoidea) have recently been recorded in Greater Glasgow, some of which may well have been spread via the horticultural trade rather than due to climate-related factors (RBW, pers. obs.).

It is possible that many plants, usually non-natives, are benefitting from climate change impacts, but systematic long-term evidence is limited. The bee orchid (*Ophrys apifera*) (Fig. 3) is a native orchid which, during the last 20 years, has spread into Scotland, as exemplified by some very recent local finds at Havoc Meadow, Dumbarton and Greenoakhill Forest, Carmyle (K. Watson, pers. comm.). It is thought that this orchid's winter-green rosettes benefit from milder winters (BSBI, 2020). In the fungus kingdom, the arrival in the Greater Glasgow area in recent years of earthstars - firstly the now widespread collared earthstar (*Geastrum triplex*), followed successively by the sessile earthstar (*G. fimbriatum*) (O'Reilly, 2020), and in 2023, the striate earthstar (*G. striatum*) - may be related to the warmer, more humid conditions.

THE FUTURE: GMBRC

At the time of writing, GMBRC is closed. Over the last 25 years demand for GMBRC's data services has grown dramatically and an official evaluation of the Centre's operations and structure is now required. Glasgow Life Museums have invited the Association of Local Environmental Records Centres (known as ALERC) to help produce a thorough business review which engages relevant stakeholders from across the Clyde area. It will take into account work being done elsewhere in the country, including the Scottish Government's Biodiversity Strategy and National Planning Framework 4 and the Better Biodiversity Data project. We anticipate that the review will create a robust development plan for GMBRC's future.

Despite the closure, GMBRC is still accepting new wildlife records and datasets to ensure the database is up-to-date for reopening. As mentioned, the database recently passed 1 million records. The millionth record input into the database was a sighting of a pellucid hoverfly (*Volucella pellucens*) (Fig. 4) in the Botanic Gardens in August 2021, which was not downloaded from iNaturalist until June 2023. The earliest dated record is of few-flowered sedge (*Carex pauciflora*) in the Arran hills on 21st June 1772, and the latest record is of a noctule bat (*Nyctalus noctula*) at Hamiltonhill Claypits LNR on 30th September 2023.

THE FUTURE: SCOTLAND

As GMBRC goes through its own development and review, the biological recording network across Scotland is also embarking on a new project: the Better Biodiversity Data project (BBD).

The BBD project arose from the activities of the Scottish Biodiversity Information Forum (SBIF) which was established in June 2012 as community-led forum bringing together stakeholders from organisations actively involved in the collecting, managing, using and sharing of biological data in Scotland. From the start, discussions within the group and the wider recording community made clear that obtaining a complete and up-to-date account of species in Scotland is hampered by a declining pool of amateur expertise, complex data flows, and gaps in data collection and service provision. In November 2018 the SBIF Forum published the SBIF Review, which detailed 24 recommendations to improve biological recording in Scotland. In December 2019 a project proposal was submitted to the Scottish Government to deliver the recommendations. This was unsuccessful. However, in late 2022, NatureScot and The Scottish Government agreed to provide £580,000

Fig. 4. Pellucid hoverfly (*Volucella pellucens*), Glasgow Botanic Gardens, 8th August 2021. (Photo: H. Murray)

over two years for the smaller BBD project. This funded project, hosted by the NBN Trust, commenced work in March 2023 and will help build the foundation of a stronger infrastructure for biological recording and biodiversity data in Scotland (Tansey, 2023).

It aims to develop the first steps in a national strategic approach to the collection, collation and sharing of biological data across Scotland and will continue to work alongside the SBIF advisory group and other key partners to address three key objectives: (1) the establishment of a National Hub that supports Local Environmental Records Centres (LERCs) and Recording Groups in Scotland; (2) the creation of a shared online data management and digital services system that can be used by LERCs, Recording Groups and other partners to streamline biodiversity data flows and help deliver data services in Scotland; and (3) the development of a more connected and better supported biological recording community in Scotland.

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APPENDIX. The number of taxa in UKSI (UK Species Inventory) for each organismal group, together with the number of taxa for which there are records in the GMBRC (Glasgow Museums Biological Records Centre) database, and the number of records of those taxa over several time periods. R6: Recorder 6 data software.

R6 Group	U.K. taxa	Taxa in GMBRC database	Records added pre-2003	Records added 2003-2013	Records added post-2013	Total records
Bacterium	399	1	1	5	211	217
Cyanobacterium	2	0	0	0	0	0
Archaean	0	0	0	0	0	0
Protozoan	516	1	12	4	1	17
Foraminiferan	144	1	9	0	0	9
Diatom	2,886	8	21	12	2	35
Slime Mould	555	14	7	8	34	49
Fungoid	421	4	1	7	5	13
Fungus	15,370	959	969	1,778	6,225	8,972
Lichen	2,391	267	662	197	222	1,081
Alga	2,985	14	4	8	45	57
Chromist	624	21	9	38	11	58
Stonewort	41	3	12	3	22	37
Liverwort	300	133	1,074	35	142	1,251
Hornwort	3	2	2	1	0	3
Moss	793	284	4,426	422	800	5,648
Clubmoss	12	4	113	33	9	155
Quillwort	5	1	1	0	1	2
Horsetail	19	10	2,701	262	316	3,279
Fern	126	38	7,740	1,112	695	9,547
Conifer	90	11	933	150	192	1,275
Ginkgo	1	1	0	0	1	1
Flowering plant	7,026	1,270	223,149	28,139	28,574	279,862
Mesozoan	21	0	1	0	0	1
Sponge (Porifera)	417	3	3	2	0	5
Placozoan	0	0	0	0	0	0
Coelenterate (=cnidarian)	536	11	15	8	10	33
Comb Jelly (Ctenophora)	4	1	0	1	0	1
Flatworm (Turbellaria)	113	10	120	97	47	264
Monogenean	1	0	0	0	0	0
Trematode	392	4	5	0	0	5
Tapeworm (Cestoda)	294	4	11	0	0	11
Ribbon Worm (Nemertea)	93	5	1	7	0	8
Rotifer	598	1	1	5	0	6
Gastrotrich	206	0	0	0	0	0
Loriciferan	3	0	0	0	0	0
Mud dragon (Kinorhyncha)	37	0	0	0	0	0
Gnathostomulid	12	0	0	0	0	0
Parasitic roundworm (Nematoda)	0	0	0	0	0	0
Roundworm (Nematoda)	791	4	9	11	3	23
Hairworm (Nematomorpha)	7	0	0	0	1	1
Thorny-headed worm (Acanthocephala)	2	0	0	0	0	0
Entoproct	51	0	0	0	0	0
Cycliophoran	1	0	0	0	0	0
Mollusc	1,966	170	2,524	2,797	2,087	7,408
Annelid	1,329	47	434	176	92	702
Pauropod	23	0	2	0	0	2
Symphylan	14	1	6	0	0	6
Acarine (Acari)	2,536	49	139	159	79	377

Spider (Araneae)	675	235	672	410	819	1,901
Harvestman (Opiliones)	31	18	76	143	196	415
Scorpion	0	0	0	0	0	0
False scorpion (Pseudoscorpiones)	24	8	21	2	4	27
Sea spider (Pycnogonida)	71	1	0	1	0	1
Crustacean	3,794	203	824	762	550	2,136
Millipede	69	38	92	306	187	585
Centipede	62	19	47	108	67	222
Proturan	11	0	13	0	0	13
Springtail (Collembola)	396	38	62	1	34	97
Two-tailed bristletail (Diplura)	12	1	2	0	0	2
Silverfish (Thysanura)	2	2	4	3	3	10
Bristletail (Archaeognatha)	7	2	7	0	1	8
Mayfly (Ephemeroptera)	53	18	46	199	155	400
Dragonfly (Odonata)	87	25	5,891	1,570	932	8,393
Stonefly (Plecoptera)	37	22	129	79	64	272
Orthopteran	48	16	194	51	85	330
Web-spinner (Embioptera)	0	0	0	0	0	0
Mantis (Mantodea)	1	0	0	0	0	0
Earwig (Dermaptera)	8	5	41	33	76	150
Cockroach (Dictyoptera)	26	7	39	1	4	44
Booklouse (Psocoptera)	91	26	67	10	20	97
Louse (Phthiraptera)	28	2	4	0	0	4
True bug (Hemiptera)	1,831	424	1,474	605	1,556	3,635
Thrips (Thysanoptera)	179	2	5	2	3	10
Stick insect (Phasmida)	5	0	0	1	0	1
Snakefly (Raphidioptera)	4	0	7	0	0	7
Alderfly (Megaloptera)	3	2	21	20	33	74
Lacewing (Neuroptera)	72	29	112	42	66	220
Beetle (Coleoptera)	3,957	1,936	25,003	2,051	4,804	31,858
Stylops (Strepsiptera)	16	2	2	0	0	2
Scorpion fly (Mecoptera)	4	3	30	33	45	108
Flea (Siphonaptera)	87	20	33	19	1	53
Caddis fly (Trichoptera)	208	113	588	326	525	1,439
Butterfly	116	49	15,484	26,115	41,450	83,049
Moth	2,780	1,297	66,074	31,512	86,857	184,443
True fly (Diptera)	7,240	1,188	6,070	5,321	6,635	18,026
Hymenopteran	8,148	549	1,351	1,914	6,373	9,638
Priapulid	4	0	0	0	0	0
Spoon worm (Echiura)	8	0	0	0	0	0
Peanut worm (Sipuncula)	25	0	0	0	0	0
Waterbear (Tardigrada)	57	0	0	0	0	0
Tongue worm (Pentastomida)	0	0	0	0	0	0
Beardworm (Pogonophora)	11	0	0	0	0	0
Horseshoe worm (Phoronida)	5	0	0	0	0	0
Bryozoan	320	6	9	1	0	10
Lampshell (Brachiopoda)	18	1	0	1	0	1
Echinoderm	158	10	8	16	1	25
Arrow worm (Chaetognatha)	20	0	0	0	0	0
Acorn worm (Hemichordata)	13	0	0	0	0	0
Tunicate (Urochordata)	124	2	0	3	0	3
Lancelet (Cephalochordata)	1	0	0	0	0	0
Jawless fish (Agnatha)	5	3	16	4	3	23
Cartilaginous fish (Chondrichthyes)	0	0	0	0	0	0
Bony fish (Actinopterygii)	596	36	287	195	60	542

Amphibian	7	5	1,505	2,108	1,698	5,311
Reptile	7	4	849	124	129	1,102
Bird	778	299	33,874	30,886	285,796	350,556
Marine mammal	39	12	31	28	26	85
Terrestrial mammal	69	33	2,332	2,852	7,669	12,853