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The Galls of Baden-Württemberg:

Curation, Digitization, Faunistics, and Public Outreach

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Table of Contents

Statutory Declaration II
Abbreviations VI
List of figures VI
List of tables VII
Abstract 1
Zusammenfassung 2
1. Introduction 3
1.1 What is a gall? 3
1.1.1 Definition 3
1.1.2 Gall morphology 4
1.1.3 Gall formers 7
1.1.4 „False galls“ 9
1.1.5 Inquilines 10
1.1.6 Parasites and predators 11
1.1.7 Gall hosts 12
1.2 Importance of galls to human history and economics 13
1.3 Importance of galls to biological research and the environment 14
1.4 Galls in Germany 16
1.4.1 German books about galls 16
1.4.2 German names for galls 17
1.5 Baden-Württemberg 21
1.5.1 The ecology of Baden-Württemberg, its climate, and habitats 21
1.5.2 Galls of Baden-Württemberg 23
1.6 Databasing and digitization 23
1.7 Objectives and hypotheses 24
2. Materials and Methods 25
2.1 Materials 25
2.1.1 Databasing and digitization 25
2.1.2 Gall checklist for Baden-Württemberg 25
2.1.3 Public outreach 25
2.2 Methods 26
2.2.1 Study area 26
2.2.2 Galls in the SMNS Entomology Collection 26
2.2.2.1 Sorting and accessioning 27
2.2.2.2 Identification of hosts and gall formers 27

2.2.2.3 Phenology and biodiversity ... 28
2.2.2.4 Distribution maps ... 28
2.2.2.5 Databasing ... 29
2.2.2.6 Digitization ... 30
2.2.3 Checklist of galls of Baden-Württemberg ... 31
2.2.4 Public outreach ... 33
3. Results ... 35
3.1 The SMNS gall collection ... 35
3.1.1 Age and history of specimens ... 35
3.1.2 Phenology ... 37
3.1.3 Gall formers in the collection ... 38
3.1.3.1 Hymenoptera ... 38
3.1.3.2 Diptera ... 39
3.1.3.3 Other gall-forming organisms ... 39
3.1.3.4 Non-gall species ... 40
3.1.4 Gall hosts in the collection ... 41
3.1.5 Unidentified material ... 42
3.1.6 Distribution maps ... 43
3.1.7 Digitization ... 45
3.1.8 Storage methods ... 46
3.2 Checklist of galls of Baden-Württemberg ... 49
3.2.1 Removed species ... 50
3.3 Public outreach ... 51
4. Discussion ... 52
4.1 Importance of historical collections ... 52
4.1.1 Phenology ... 52
4.1.2 Gall formers ... 53
4.1.3 Gall hosts ... 54
4.1.4 Distribution ... 54
4.1.4.1 Unsampled parts of Baden-Württemberg ... 55
4.1.5 Storage methods ... 56
4.1.6 Research benefits from a gall collection ... 58
4.1.7 Limitations of the databasing and digitization project ... 59
4.2 Gall checklist of Baden-Württemberg ... 60
4.2.1 New records for Baden-Württemberg ... 60
4.2.2 Limitations of the checklist project ... 60

4.2.3 Importance of species checklists 61
4.3 Public outreach 62
4.4 Further research 63
5. Conclusion 64
6. Acknowledgments 65
7. References 66
7.1 Literature 66
7.2 Figure references 73
8. Appendix 76

Abbreviations

&	and
%	percent
°C	degree Celsius
BC	Before Christ
CUID	collection unit identifier
DB	digital back
DWB	Diversity Workbench
F	focal length
GPS	Global Positioning System
ISO	International Standards Organization
km^2	square kilometer
m	meter
mm	millimeter
SMNS	State Museum of Natural History Stuttgart
sec	seconds
TK25	topographical map on a scale of 1/25,000
WGS 84	World Geodetic System 1984

List of figures

Figure 1: *Pediapsis aceris*. 3
Figure 2: Inside a gall, there is life. 4
Figure 3: *Neuroterus numismalis* (Image credit: SMNS) 4
Figure 4: *Trigonaspis megaptera* (Image credit: SMNS) 5
Figure 5: Leaf roll made by *Apoderus coryli*. It is not a true gall. 10
Figure 6: *Torymus bedeguaris* 11
Figure 7: *Macrodiplosis pustularis* (Image credit: SMNS). 18
Figure 8: *Neuroterus quercsbaccarum* (Image credit: SMNS) 18
Figure 9: *Cynips divisa* (Image credit: SMNS) 18
Figure 10: *Biorhiza palida* (Image credit: SMNS) 19
Figure 11: *Cynips longiventris.*(Image credit: SMNS) 19
Figure 12: *Neuroterus numismalis* (Image credit: SMNS) 19
Figure 13: Witch's broom on birch. (Image credit: Wikimedia Commons). 20
Figure 14: Robin's pincushion on wild roses. (Image credit: SMNS) 20
Figure 15: Map of Germany (Image credit: Wikimedia Commons). 21
Figure 16: Mapping function in the DWB. (Image credit: DWB). 28

Figure 17: Screenshot of the Diversity Workbench. (Image credit: DWB). 29
Figure 18: Digitization layout (Image credit: SMNS) 30
Figure 19: *Kiefferia pericarpiicola* 31
Figure 20: The look of the SMNS Science Blog (Image credit: SMNS). 33
Figure 21: The look of the Nixenzauber Blog (Image credit: Mertz & Mört). 34
Figure 22: Phenology of gall samples. 37
Figure 23: Gall formers in the SMNS. 38
Figure 24: Number of gall specimens 41
Figure 25: Distribution map (Image credit: DWB) 43
Figure 26: Stuttgart area distribution map (Image credit: DWB) 44
Figure 27: Digitization. First image (Image credit: SMNS) 45
Figure 28: Digitization. Second image (Image credit: SMNS) 45
Figure 29: Three different kinds of envelope storage. 46
Figure 30: Herbarium sheet by T. Breunig (Image credit: SMNS). 46
Figure 31: “Notebook” with galls by Antonio Wünsch. 47
Figure 32: Clear plastic folders filed in a ring binder. 47
Figure 33: Cardboard box. 48
Figure 34: Insect drawer (Image credit: SMNS). 48
Figure 35: Insight into the gall article on the blog Nixenzauber (Image credit:Mertz & Mört). 51

List of tables

Table 1: German-language books about galls. 16
Table 2: Some examples of galls and their German names, with English translations. 18
Table 3: SMNS gall collectors by time period. 35
Table 4: Gall former orders in the SMNS gall collection. 38
Table 5: Eight new records of Hymenoptera species for Baden-Württemberg. 39
Table 6: Four new records for Diptera species for Baden-Württemberg. 39
Table 7: Four new records of other gall-inducing organisms for Baden-Württemberg. 40
Table 8: Overview of host order. 42
Table 9: Non-galling species. 50
Table 10 First gall checklist of Baden-Württemberg.. 76

Abstract

Galls play an important role in nature, science, and environmental protection but are relatively unknown to the public.

For the main part of the Master project, all gall specimens from the State Museum of Natural History Stuttgart (SMNS) were studied, and those from Baden-Württemberg were cataloged. The first checklist of galls for Baden-Württemberg was compiled from the SMNS collection and further literature. It includes 890 species, of which 105 species are first records for Baden-Württemberg.

Based on the checklist, we hypothesized that the arthropod diversity of the gall collection at SMNS would reflect the arthropod gall diversity of Baden-Württemberg. The data did not support this hypothesis. Of the 371 gall-forming arthropod species of Baden-Württemberg, only 93 were represented in the collection. We found a strong collecting bias toward oak gallers, which formed 40 % of the collection. In addition, many areas of Baden-Württemberg are still uncollected. For example, very little is known of the gall fauna of the Black Forest.

Three hundred ninety-five specimens from the collection were cataloged in the Diversity Workbench (DWB). In addition, 68 of the 395 objects were digitized, and images were made accessible through the DWB. Digitization of museum objects is important both for a better collection overview and for access worldwide. This ensures better accessibility for scientific research and nature conservation. In addition, different curation methods were described and evaluated. Storage in insect drawers and unit trays was advised.

Through this work, digitization was improved, public outreach was done, and the first checklist of galls of Baden-Württemberg was created. The checklist includes 16 new state records from the SMNS gall collection: 8 Hymenoptera, 4 Diptera, and 4 Hemiptera.

Another focus of this study was public outreach. Two blogs and social media were used to report on galls, thus bringing the topic to the public and promoting knowledge of the species and dissemination of knowledge.

Zusammenfassung

Gallen spielen in der Natur, in der Wissenschaft und im Umweltschutz eine wichtige Rolle, sind in der allgemeinen Bevölkerung aber eher unbekannt.

Für den Hauptteil der Masterarbeit wurden alle Gallen aus dem Staatlichen Museum für Naturkunde Stuttgart (SMNS) gesichtet und jene aus Baden-Württemberg katalogisiert. Dabei wurde die erste Gallenliste für Baden-Württemberg aus der Sammlung des SMNS und der weiterführenden Literatur erstellt. Die Gallenliste enthält 890 Arten, wovon 105 Arten Erstnachweise für Baden-Württemberg sind.

Die aufgestellte Hypothese, dass die Vielfalt der Gallensammlung des SMNS die Vielfalt der Arthropoden-Gallen in Baden-Württemberg widerspiegeln würde, wurde durch die Daten nicht bestätigt. Von den 371 gallenerzeugende Arthropoden-Arten Baden-Württembergs waren nur 93 in der Sammlung vertreten. Im Verhältnis waren in der Sammlung vor allem Eichengallen vertreten, welche 40 % der Sammlung ausmachten. Zudem sind viele Gebiete in Baden-Württenberg noch nicht erfasst. So weiß man zum Beispiel nur wenig über die Gallen-Fauna des Schwarzwalds.

395 Objekte aus der Sammlung wurden in der Diversity Workbench (DWB) aufgenommen. Außerdem wurden 68 der 395 Objekte fotografisch festgehalten und über die DWB zugänglich gemacht. Die Digitalisierung der Museumsobjekte ist sowohl für eine bessere Sammlungsübersicht, als auch für den weltweiten Zugriff wichtig. So können die Sammlung und die damit verbundenen Informationen besser für die wissenschaftliche Forschung und den Naturschutz genutzt werden. Zudem wurden die unterschiedlichen Aufbewahrungsmöglichkeiten betrachtet und die Aufbewahrung in Insektenkästen und Boxen als Einheitsfächer empfohlen.

Durch diese Arbeit wurde die Digitalisierung der Sammlung verbessert, Öffentlichkeitsarbeit gemacht und die erste allgemeine Übersichtsliste der Gallen in Baden-Württemberg erstellt. Die Liste enthält 16 neue Arten für Baden-Württemberg aus der Gallensammlung des SMNS. 8 Hymenoptera, 4 Diptera und 4 Hemiptera.

Ein weiterer Fokus dieser Arbeit war die Öffentlichkeitsarbeit. Mit Hilfe zweier Blogs und Social Media, wurden Informationen über das Thema Gallen in der Öffentlichkeit verbreitet, um damit das Wissen und Artenkentnisse inerhalb der Bevölkerung zu fördert.

1. Introduction

1.1 What is a gall?

1.1.1 Definition

Figure 1: Galls on a leaf. An “unusual outgrowth” of the plant. *Pediapsis aceris* (Hartig 1841) galls on *Acer*.

Galls are unusual outgrowths of tissue (Figure 1). However, it is not easy to find a definition for galls. Some scientists have tried to make a clear one, but there is no official definition for galls. Many definitions include phrases such as „tumor-like growths“. The first “definition” is from Malpighi (1687), who is considered the founder of gall science (cecidology): “Morbosis frequenter suberescentibus tumoribus, quos Gallarum nominibus exponemus” (Pathological swellings commonly occurring, to which we will refer with the term of "Galls").

A frequently cited definition is from Csoke (1997): „A gall is an abnormal growth on some part of the plant in which the number and/or the size of cells is increased relative to the normal state due to the activity of another organism. The gall-causing organism uses this structure as both a shelter and a source of nutrition. It is important to emphasise that the gall former induces the formation of the gall by the plant, rather than making the gall itself.“

The most recent definition for galls is from Redfern et al. (2002): “A gall is an abnormal growth produced by a plant or other host under the influence of another organism. It involves enlargement and/or proliferation of host cells and provides both shelter and food or nutrients for the invading organism.” This definition includes the possibility that galls also can be found on other organisms, such as fungi. Other plant formation abnormalities, such as animal feeding marks, are excluded.

Kopelke (2008) describes galls “as the result of a balanced interaction between a pathogen and the infected plant. Galls provide a safe area and food for the inhabitants and are essential for their reproduction. Thus, each gall represents a micro-ecosystem in itself”.

The scientific name for galls is cecidium (the Greek word “cecis” means the swelling forth). This scientific name was first used in 1873 by Friedrich August Wilhelm Thomas

(1840–1918), a zoologist, botanist, and teacher in Ohrdruf, Thuringia, Germany (Ross 1911).

Galls are growths on a plant or other organism that are limited in time and space. Galls are caused by substances produced or induced by a parasite. The parasite may be another plant, bacteria, fungi, or animal (Bellmann et al. 2018). The mother can release modification substances with the egg-laying or by the larva itself. In this process, gall formers control the growth and development potential of the host tissue. They are gene regulators and can switch host genes on and off (Küster 1911).

Figure 2: Inside a gall, there is life. A gall from wild carrot, *Daucus carota*, with a hymenopteran pupa inside.

Inside the galls, there is life (Figure 2). The host forms a protective shelter for the parasite. It is also a food source for the parasite. The host spends its energy on another organism. Life inside a gall has immense benefits for the gall former or its offspring. Inside the gall, there is a comfortable, stable microclimate., At its own expense, the host provides protection and food to the gall-former or its offspring (Czech 1858).

1.1.2 Gall morphology

Galls can be found in different places on the host organism. All places with living tissue are possible: roots, stems, leaves, and flowers. The location and host choice are often specific to the gall former. It does not always matter if the host already has another gall. Often there are many galls of the same species on one host. For example, *Neuroterus numismalis* (Geoffroy 1785) can cause over 100 galls on a single oak leaf (Figure 3). Galls can be individually delimited or grouped and form whole complexes.

Figure 3: Oak leaf with many *Neuroterus numismalis* (Geoffroy 1785) galls (Image credit: SMNS).

In principle, all plant groups, or other organisms like fungi, can be taken as hosts, but many gall-formers are specialists. They are host-specific, in many cases to a family, a genus, or even to only one species. Specialization on one subspecies may even be possible (Benz 1998).

Most organisms are also organ and tissue-specific. For example, *Trigonaspis megaptera* (Panzer 1801) only forms galls on oak leaves. The specialization can go even further so that individual galls on a leaf are formed only on the stem, others only on the leaf veins (Figure 4), on the leaf margin, or the underside of the leaf.

Figure 4: These *Trigonaspis megaptera* (Panzer 1801) galls are specialized on the veins of oak leaves (Image credit: SMNS).

It is also possible that different gall former species specialize on the same host species, even the same host organ. This is very common on oaks. In Central Europe, it is the oaks on which the greatest number and variety of galls are found. English oak (*Quercus robur* L. 1753) and Sessile oak (*Quercus petraea* Lieblein 1784) and their hybrids „are at the top of the league with about 50 species" (Redfern & Shirley 2011). It often happens that many different gall species are found on a single oak leaf.

Besides the oligophagous gall formers, which are highly specialized to host family or genus, some generalists do not care about the species or family. Most gall-forming nematodes are polyphagous, meaning they have an extensive host range (Hellrigl 2010).

The morphology of galls varies widely, and many species have a unique individual look. The aim of a gall former is protection and nourishment. All gall formers have similar goals, but the realization is as diverse as the gall formers themselves. From minimal swelling to fantastic outgrowths, everything is possible. A distinction can be made between organoid galls and histoid galls. Organoid galls are just changes in size, such as tiny swellings or branches. Histoid galls show unusual and bizarre outgrowths. They look very different from the typical host tissue (Küster 1911).

The host and the characteristic morphology of the gall, especially in the case of histoid galls, often allow for identification of the gall former.

There are different terms for different gall forms (Küster 1911, Bellmann et al. 2018):

Felt galls are caused by gall mites. They are hairy patches or clumps of hairs on leaves where the Acari live and are protected.

In **rolled galls** or **folded galls**, the leaf margin or a larger part of the leaf is rolled or folded. This creates a protective space. They are caused by many gall-forming organisms like Acari, Cecidomyiidae, Aphidoidea, and Tenthredinidae.

Pit galls cause a pit or depression on one side of a leaf, with a raised area on the other side. They are found on leaves and caused by Acari, Psylloidea, or Coccoidea.

Bubble galls or **blister galls** are like pit galls with a protective membrane, resembling a blister pack for medicine. Acari or Cecidomyiidae causes them.

Pouch galls take the form of hollow swelling of the leaf. On one side, a pouch or dome with an opening is formed. Acari, Cecidomyiidae, Aphidoidea, and Psylloidea can cause pouch galls.

Closed galls are often very complex. The host tissue completely encloses the gall former or its offspring. The female oviposits directly in the host tissue, or the larva feeds into it, and the gall grows around it. Cecidomyiidae, Cynipidae, Tenthredinidae, Psylloidea, and Tephritidae can create closed galls.

Flower bud galls and **rosette galls** are enlarged flower buds or transformed leaves. Rosettes and pineapple-like shapes are possible. Cecidomyiidae, Cynipidae or Aphidoidea induce them. If several gall formers of one species are present at the same time, the galls may combine to form complexes (Küster 1911, Bellmann et al. 2018).

Ambrosia galls are galls with a special symbiosis. For example, some Cecidomyiidae have a symbiotic relationship with fungi (Neger 1910).

1.1.3 Gall formers

Gall formers can be found in many families and orders of living organisms. They are not limited to a related group and are found in the animal kingdom, in the kingdom of bacteria, plants, and fungi. The majority of described gall-forming species belong to the animal kingdom. They are best known in the class of insects, but many nematodes and mites also form galls.

Mites and insects are the most common cecidogenic representatives of the animal kingdom. Their common names often identify them as gall-forming organisms: gall mites, gall midges, gall wasps. In the class of insects, both hemimetabolous and holometabolous gall formers can be found (Bellmann et al. 2018).

Hemiptera are hemimetabolous insects with sucking mouthparts. Hemiptera form galls that are not entirely closed or galls that open at maturation. Hemiptera is traditionally divided into two groups, the Heteroptera and Homoptera. The Heteroptera are known as the “true bugs”. Only two species of Heteroptera are known to form galls in Europe. They induce enormously swollen flower buds of the host plant. Their galls are not completely closed at the top. Psylloidea, Aphidoidea, or Coccoidea make the Homoptera galls. Many Psylloidea and Aphidoidea secrete wax to protect their bodies from dehydration and honeydew (Bellmann et al. 2018). Scale insects (Coccoidea) are not typical gall formers. Females are often mistaken for galls because they are sessile and may resemble plant tissue. Only a few truly induce galls. The galls of scale insects include blister, pit, pouch, bud, or rosette, and roll or folded galls (Gullan et al. 2005). An example of a gall-inducing scale insect is *Asterodiaspis variolosa*.

In the order **Coleoptera**, only a small number of gall formers are known. Some Curculionoidea are of interest as well as of Chrysomeloidea. Curculionoidea are the richest in gall-inducing species. Besides these superfamilies, gall-like swellings on twigs and roots are induced by some Burprestidae species and only a single species, each of Mordellidae and Nitidulidae (Korotyaev et al. 2005).

In the order **Lepidoptera,** there are relatively few gall formers. Lepidoptera causes 352 gall types, but 173 have only been identified to order. The 179 identified species range over 20 families and 11 superfamilies. The families' richest in galls are the Gelechiidae and Tortricidae (Miller 2005).

One family of Nepticuloidea, three of Incurvarioidea, two of Gracillarioidea, three of Yponomeutoidea, five of Gelechioidea, one of Sesioidea, one of Tortricoidea, one of Alucitoidea, one of Pterophoroidea, and one family of Thyridoidea induce galls. Most lepidopteran galls are swellings on stems, roots, or leaves (Miller 2005).

Diptera: The order of Diptera includes many gall formers. Among them, there are only a few representatives in Cyclorrhapha, such as some Tephritidae and Drosophilidae. Most dipteran gall formers belong to the Nematocera or “lower” flies. The gall midges (Cecidomyiidae) are the most species-rich group of gall-formers. Worldwide, 6203 species in 763 genera of living and fossil gall midges are known (Gagné & Jaschhof 2014). Over 800 species are native to Germany (Meyer & Jaschhof 1999). However, only around 60% of species induce galls. The family also includes fungus feeders, predators, and gall inquilines (Raman et al. 2005).

Hymenoptera: Most gall-inducing Hymenoptera belongs to Tenthredinidae and Cynipidae. A few species of Chalcidoidea and Braconidea are known, too. In the family of Cynipidae, more than 1400 species have been described. They are the second most species-rich group of gall insect inducers after the gall midges (Cecidomyiidae) (Liljeblad & Ronquist 1998, Melika 2006). In Europe, there are around 250 cynipid species. Not all of them induce galls. Some of them are gall inquilines (Bellmann et al. 2018). About half of the gall-forming gall wasp species are found on oaks. Roses are another common host plant for cynipid galls. Some Cynipidae have bisexual generations that produce galls in different places. For example, in *Biorhiza pallida*, the parthenogenetic generation parasitize plant roots of oaks in late autumn, and the sexual generation parasitizes oak flower buds in late spring (Küster 1911, Liljeblad & Ronquist 1998, Bellmann et al. 2018).

Tenthredinidae are sawflies, an early diverging hymenopteran group without the typical "wasp waist". Many gall-inducing species are known from the genus *Euura*. Worldwide 658 *Euura* species are described (Taeger et al. 2018). These are often host-specific to *Salix* and form bubble leaf galls and simple galls on leaf margins, recognizable as folded-over or curled leaves. One species, *Hoplocampoides xylostei,* form swelling of young shoot on honeysuckle (*Lonicera*, Caprifoliaceae).

Acari (mites) are arachnids, not insects. However, together with the insects, they induce the most galls. Only trombidiform mites induce galls. Most gall-inducing species of Acari belong to the Eriophyoidea (Oldfield 2005). Mite galls exhibit incredible

diversity, from small hairs to conspicuous pouch galls. Such galls are often obvious and easy to spot in nature. They frequently occur on leaves (Bellmann et al. 2018).

Nematoda are often generalists with a very wide host range. Many dwell in the soil and infest plant roots, producing simple swellings called "nodules" (Huber 1975).

Bacteria: The best known bacterial galls are probably nitrogen-fixing bacteria. These are unusual among gall formers, as they have a symbiotic rather than parasitic relationship with the host. The *Rhizobium* bacteria symbiosis with legumes is important for global agriculture (Brewin 2010). However, many other bacterial galls are not beneficial to the host. For example, *Agrobacterium tumefaciens* can induce huge growths on *Platanus* bark.

Plants can also induce galls. It is rare, but it does happen with parasitic plants. For example, *Viscum album* can induce gall-like swellings where its haustoria enter the host tissue (Bellmann et al. 2018).

Fungi: Galls are also known from the kingdom of fungi. The gall formers are found in the subkingdom Dikarya, the “higher fungi”, in the Ascomycota, Basidiomycota, Oomycota, Phytomxea, and Chytridiomycetes (Bellmann et al. 2018).

1.1.4 „False galls“

Many unusual structures on plants are not galls. These include formation abnormalities, such as feeding marks of animals. By the definition of Redferd et al. (2002), these variances are knowingly excluded. They are not galls because they do not involve enlargement and/or proliferation of host cells. Nevertheless, sometimes it is difficult to decide whether a gall is present or not.

With some abnormalities, it is obvious that it is a gall, for example, histoid galls caused by Cynipidae on oak. However, some insect feeding structures can be confused with galls. Leaf mines, for example, are feeding tunnels or places inside the leaves. Most of them do not look like galls, but sometimes they are swollen or gall-like. For example, *Cystiphora taraxaci* (Cecidomyiidae, Diptera) is described as gall by Bellmann et al. (2018) because it looks like a blister gall. In “Plant Parasites of Europe”, they are described as mines (Ellis 2021).

Incorrectly believed to be galls are various structures made out of plant parts, formed by other organisms like *Apoderus coryli* (Attelabidae, Coleoptera). These beetles roll the leaf and lay eggs inside (Figure 5). The larvae feed on rotten leaf tissue. The beetle does not regulate the plant host genes or otherwise modify the growth of the plant.

Figure 5: Leaf roll made by *Apoderus coryli*. It is not a true gall.

In some works, nests of spittlebugs (Cercopoidea, Hemiptera) are described as galls, like in Buhr (1964/1965). Spittlebugs feed on the xylem of plants and produce spittle by themselves with special breathing tubes.

There are also insects with unusual looks, such as scale insects. Adult female scale insects are sessile or semi-sessile plant parasites, and the legs are reduced or hidden under the scale. They can look like galls and are sometimes dried and preserved with plant material in the same way that a gall would be.

Sometimes, a fungal infection can resemble galls. Even though there are fungi that create galls, not all of them do.

The decision of whether a gall is present or not is sometimes not easy to make. However, a true galler induces physiological changes in the plant. It often helps a look inside the structure and examines the tissue growth.

1.1.5 Inquilines

The word inquiline is from the Latin word “inquilineus” and means tenant or guest. The one-sided relationship of inquilinism benefits only the inquiline and has no direct detrimental effects on the partner. There are many examples of inquilinism in Hymenoptera, especially in the social hymenopteran groups of bees, wasps, and ants (Askew 1984).

An inquiline is an animal that lives with the gall former inside the gall. “Inquilines range from being commensals, having little or no impact on the galler whose gall has been invaded, to being virtually natural enemies of gallers in that they may facultatively or obligatorily kill the galler and take over the gall” (Sanver & Hawkins 2000).

Inquilines often lay their eggs in the developed galls. Thus, the offspring get the protection and food that the gall offers. Generally, the tenant lets the gall former or its descendants live in peace. In a few cases, however, the original occupant may be damaged and killed. The gall former may be outcompeted for food or even killed by encountering the inquiline larva. It is also possible that a by-product kills the gall former, for example, in the case of *Dichatomus acerinus* (Eulophidae, Hymenoptera), an inquiline of *Pediaspis aceris* (Cynipidae, Hymenoptera) (Bellmann et al. 2018).

Normally, inquilines cohabit with the gall producer in the gall and hatch from the gall at similar times. The development time is correspondingly adapted to that of the gall former (Bellmann et al. 2018). From an evolutionary perspective, inquilines used to be able to create galls themselves. They have unlearned this ability and evolved from gall former into inquilines that feed on the galls of other organisms. However, they can use and sometimes even modify galls already present (Brooks & Shorthouse 1998).

It is also not uncommon that more inquilines than actual gall formers hatch from the galls. It even often happens that only inquilines or parasites leave the gall. From the galls of *Biorhiza pallida* alone, 79 parasites and 11 inquilines are known (Küster 1911).

After the galls are empty, they are used by other organisms for shelter. For example, they are used by bees or sphecoid wasps as a hiding or nesting place (Küster 1911, Westrich 2008).

1.1.6 Parasites and predators

Unlike inquilines, parasites and parasitoids directly harm the gall former. Parasites live on the larvae (ectoparasites) or inside the larvae (endoparasites). Many parasitic wasps use galls for their development. If they completely take the place of the gall formers and kill or eat them, they are called parasitoids. Most parasites are specialized to certain types of gall and have co-evolved with the gall formers. In galls develop many chalcid wasps (Hymenoptera: Chalcidoidea), especially different species of Torymidae. Like inquilines,

Figure 6: *Torymus bedeguaris* (Torymidae) – is a hyperparasite of *Orthopelma mediator* (Ichneumonidae), with is a parasite from the gall forming *Diplolepis rosae* (Cynipidae), and a primary parasitoid of *Diplolepis rosae*. It has an elongate ovipositor to lay eggs deep inside the gall tissue.

the eggs are often laid directly in the gall. Therefore, torymid females have an extra-long ovipositor (Figure 6).

The host and the parasite influence each other by bottom-up and top-down influence. These phenomena are seen in nature: every few years, there is a special “gall year” with many galls. Parasitization across several trophic levels is not unusual. This then results in a complicated network of relationships. The ecological effects of a "gall year" are then found in all parasite levels (Bellmann et al. 2018).

Due to the influence of parasites or inquilines, the galls can change. They do not fall off the host or fall off later, change in size, or build up more structures. However, it is also possible that there are no structural changes.

In addition to parasites and inquilines, gall formers have other enemies. For example, some animals destroy the galls to eat the larvae. This has been observed in birds, as well as in squirrels, ants, and lizards (Küster 1911).

In any case, galls are often used as a base for fungal growth. Many galls are infused or overgrown. The fungi have either no influence on the galls or affect them in the same way as other tissues (Küster 1911).

There are also exceptions. In the so-called ambrosia galls caused by Cecidomyiidae, there is a symbiosis between the gall-forming organism and the fungus. The fungus acts as food for the larva and is injected together with the egg. Therefore, these fungi positively affect the gall and its inducer and may even be considered a part of the gall-forming complex (Neger 1910).

1.1.7 Gall hosts

It is not without reason that cecidology is often called the science of plant galls. It is customary to refer to "plant galls" when discussing galls. This is because galls are not only found on plants. Fungi can also be hosts for galls. Until the late 20th century, fungi were considered plants until they were given their own kingdom. It is important to remember that fungi and lichens can also be gall hosts (Küster 1911).

Most galls are found on plants. Plants that become gall hosts are found in all major groups of the plant kingdom: bryophytes, pteridophytes, gymnosperms, and

angiosperms. However, the distribution is unequal. Angiosperms have a large diversity of galls, while the species-rich classes of cryptogams have only a few (Küster 1911).

The majority of galls species are found in flowering plants. Preferred families are Fagaceae with the genera *Fagus* (beech) and especially *Quercus* (oak), from which over 900 different gall-forming species are known. The Rosaceae, with around 500, and the Cruciferae, with about 250 different galls, are also very well represented (Huber 1975).

1.2 Importance of galls to human history and economics

The pioneer of scientific cecidiology or gall science was the Italian biologist Marcello Malpighi (1628–1694). In his book about plants, “Opera omnia. Partis Secundae Anatomiae Plantarum: De Gallis”, he deals with galls in one chapter and describes more than 60 species in detail. Through detailed observations and investigations, he attributes the development of galls to the settling of insects or other organisms. He also recognizes fungi as gall-forming organisms (Küster 1911, Malphigi 1687).

However, galls have been known much longer and have been used for centuries. Galls were mainly used in the pharmaceutical field, but they also had household applications. As early as 460–377 BC, Hippocrates used galls as medicines. Many galls and some of their uses are Theophrast described by (371–286 BC). According to him, galls were used to make candle wicks or to refine alcohol. Galls were also used in ancient Egypt to make ink and to ferment leather.

The first medieval naturalist to mention galls was Albertus Magnus (1193–1280, German scholar and bishop). His great botanical work “De vegetabilibus libri” mentioned the galls of the oak. In this work, the fate oracle of the galls was mentioned: In January or February, a gall was opened and its contents examined. If it is a fly, war is expected. A "little worm" indicates expensive times to come. If there is a spider in it, the oracle predicts pestilence or death.

Konrad von Megenberg (1309–1374) also mentions this fate oracle, also called weather oracle, in his "Book of Nature". This work includes descriptions of galls, which he calls "leaf apples" (Küster 1911).

The oldest herbal book in which galls are mentioned is the "Hortus sanitatis" (the author is unknown. Occasionally, Johann Wonnecke von Kaub is incorrectly named as the author. The book was published in Juni 1491 in Mainz by Jacob Meydenbach). This contains the oldest illustration of a gall, in the scientific sense of research: *Cynips tinctoria* (now *Andricus gallaetinctoriae*). In general, the herbal books mostly treated the galls of the oak because their medicinal use is particularly diverse. Thus, according to an herbal book by Bork, which appeared in Strasbourg in 1577, they were used for the following things: mouth hygiene, to stop bleeding, against nausea, various gynecological treatments, for coloring hair, to ferment leather, and for the production of ink. Other galls and their uses are also mentioned. For example, *Diplolepis rosae* (Linnaeus 1758) were used against sleep disorders (Küster 1911).

The following two centuries saw many scientific contributions on galls, their biology, anatomy, etiology, and evolutionary history, especially in the 19th century. Many species were described during this period, both for Germany and Europe (Küster 1911).

Due to their many uses, galls have long played an important role in the economy. They were used for fermenting leather as late as the 19th century and as ink until the 20th century. Galls are also traditionally used for medical treatment. Therefore, "the good" galls were imported to Germany by the sack, especially from more eastern and southern countries (Küster 1911). Galls are still used to make oak gall ink. The oak gall ink is still used today for important documents and calligraphy (Team Tinten Center 2018).

In agriculture, the *Rhizobium* bacteria play an important role or global agriculture (Brewin 2010). These gall-forming bacteria live in symbiosis with Fabaceae. They can fix nitrogen and so support the soil and the plants. The plants on the naturally fertilized soil grow better, and the harvest is more productive. Otherwise, galls are usually considered economic pathogens because they are parasites and damage plants (Bellmann et al. 2018).

1.3 Importance of galls to biological research and the environment

To understand biological relationships and to notice changes, it is important to take a closer look at the entire complex ecosystem. This includes galls. Some galls, especially

those on oaks, are already well studied and offer extensive knowledge about various inquiline and parasitic species and their biology. However, many galls are little studied and still provide many mysteries. Therefore, to make connections and discover new knowledge, it is important to do further research and combine the knowledge of the past and what has been newly learned. A knowledge of galls also helps to better understand the state of biodiversity. It is very important to keep our knowledge about species from being lost (State of Baden-Württemberg 2019).

The collections in museums and universities contain treasures that give us insight into distribution, change, and species diversity. Through scientific research into ecosystems and their various organisms, we get information about the state of species and their way of life. These help us find out what mechanisms are behind the extinction of species and what measures we need to take to protect biodiversity. In this way, knowledge about galls also helps to protect nature.

With such a great diversity of species, galls form an important habitat. They play an important role in biological relationships and influence both the animal and plant world. They link multiple trophic levels. Gall-forming organisms act as bioregulators and balance the distribution of plants and fungi. By regulating the development and distribution of some species, other plants and fungi species can take up niches that would otherwise be occupied. The gall-forming organisms, in turn, are regulated by their parasites. In addition, the larvae or adult organisms often function as a food source for other animals, for example, birds. Empty galls are also a hiding or nesting place for lots of different animals (Westrich 2008). The entire ecosystem is finely balanced. Small changes can lead to unforeseeable consequences. Everything is interconnected, and so also galls have their place in nature.

Although galls are thus important in nature and science, and many scientific articles can be found, galls are not well known by the general public. They are rarely mentioned in children's books and are also unknown in daily life. Galls are seen in nature but are usually not noticed at all. Mostly, one comes to the galls only by luck. A contribution to species knowledge and the spread of knowledge about galls was made by NABU in 2014 in its magazine “Naturschutz heute” (Nature Conservation Today) (May 2014), as well as by Gerstenberg Verlag with its nature book for children: “Die wunderbare Welt der Eiche” (The Wonderful World of the Oak) (Müller 2020). To

make the knowledge of galls again visible to the general public, they need to be mentioned more often in children's books, on social media, or in daily life.

1.4 Galls in Germany

In Germany, many scientists and hobbyists have been historically interested in galls. There are more than a thousand different galls known to occur in the country (May 2014).

1.4.1 German books about galls

Many papers and books about galls have been published in Germany. There is a little overview of German gall books published over the last 150 years in the following list. Only German-language books that focus only on galls are included (Table 1).

Table 1: German-language books about galls.

Year	Book title (German)	Author	Publisher	Reprints
1858	Neue Eintheilung der Pflanzengalle	Czech, Karl	Gross, Barth & Co., Düsseldorf	
1892	Die Gallmücken des Königl. Museums für Naturkunde zu Berlin	Ewald H. Rübsaamen		October 2019 Hansebook Publishing
1894	Über australische Zoocecidien und deren Erzeuger	Ewald H. Rübsaamen		October 2019 Hansebook Publishing
1896	Zurückweisung der Angriffe in J. J. Kieffer's Abhandlung:: Die Unterscheidungsmerkmale der Gallmücken	Ewald H Rubsaamen		October 2019 Hansebook Publishing
1889	Gronlandische Mycetophiliden, Sciariden, Cecidomyiden, Psylliden, Aphiden Und Gallen	Ewald H Rubsaamen		
1890	Beitrage Zur Kenntniss Der Europaischen Zoocecidien Und Der Verbreitung Derselben	Georg Hieronymus	G.P. Aderholz, 1890, Breslau	February 2010 Kessinger Publishing, LLC
1890/ 1891	Die Gallbildungen (Zoocecidien) Der Deutschen Gefässpflanzen: Eine Anleitung Zur Bestimmung derselben	D. Hermann, R.Schlechtendal	R. Zöckler, Zwickau	April 2010 Kessinger Publishing, LLC
1891	Pflanzengallen und Gallentiere	Dr. Karl Eckstein	R. Freese, Leipzig	
1910	Gallen und Gallwespen: Naturgeschichte der in Deutschland vorkommenden Wespengallen und ihrer Erzeuger.	Max Riedel	K.G. Lutz Publishing, Stuttgart	
1911	Die Pflanzengallen (Cecidien) Mittel- und Nordeuropas: ihre Erreger und Biologie und Bestimmungstabellen. 1. Auflage	Ross	Fischer Publishing, Jena	2nd improved edition 1927

1911	Die Gallen der Pflanze – Ein Lehrbuch für Botaniker und Entomologen	Dr. Ernst Küster	S. Hirzel Publishing, Leipzig	
1911-1924	Die Zoocecidien, durch Tiere erzeugte Pflanzengallen Deutschlands und ihre Bewohner, Band 1	Ewald H. Rübsaamen, Hans Hedicke	E. Schweizerbart Publishing, Stuttgart	2018, Forgotten Books Publishing
1916	Die Pflanzengallen Bayerns und der angrenzenden Gebiete	H. Ross	Gustav Fischer Publishing, Jena	
1917	Die fremddienliche Zweckmässigkeit der Pflanzengallen und die Hypothese eines überindividuellen Seelischen	Erich Becher	Publishing Veit, Leipzig	
1925-1939	Die Zoocecidien, durch Tiere erzeugte Pflanzengallen Deutschlands und ihre Bewohner, Band 2	Ewald H. Rübsaamen, Hans Hedicke	E. Schweizerbart Publishing, Stuttgart	
1927	Die Pflanzengallen (Cecidien) Mittel- und Nordeuropas - ihre Erreger und Biologie und Bestimmungstabellen. 2. Auflage	Ross H. and Hedicke H.	Gustav Fischer Puplishing, Jena	
1932	Praktikum der Gallenkunde (Cecidologie) Biologische Studienbücher XII	Ross H.	Publishing Springer, Berlin	
1933	Geschichte der Cecidologie: Ein Beitrag zur Entwicklungsgeschichte naturwissenschaftlicher Forschung und ein Führer durch die Cecidologie der Alten. Mit einer vorgeschichte zur Cecidologie der klassischen Schriftsteller von Felix von Öfele. 1. Teil	Konrad Böhner	Arthur Nemayer Puplishing house. Gesellschaft für Geschichte der Pharmazie, Mittenwald	
1936	Geschichte der Cecidologie: Ein Beitrag zur Entwicklungsgeschichte naturwissenschaftlicher Forschung und ein Führer durch die Cecidologie der Alten. – Botanik und Entomologie	Konrad Böhner	Arthur Nemayer. Gesellschaft für Geschichte der Pharmazie, Mittenwald	
1964/65	Bestimmungstabellen der Gallen (Zoo- und Phytocecidien) an Pflanzen Mittel- und Nordeuropas	Dr. Herbert Buhr	Jena	
1979	Reihe: Erlebte Biologie: Pflanzengallen am Wegesrand - Entstehung und Bestimmung	Rolf Beiderbeck; Ingo Koevoet	Publishing house Kosmos, Stuttgart	
2012	Geheimnisvolle Pflanzengallen Ein Bestimmungsbuch für Pflanzen und Insektenfreunde	Heiko Bellmann	Publishing house Quelle & Meyer, Wiebelsheim	
16.08.2018	Faszinierende Pflanzengallen Entdecken – Bestimmen – Verstehen	Heiko Bellmann, Margot Spohn, Roland Spohn	Publishing house Quelle & Meyer, Wiebelsheim	
16.10.2018	Pflanzengallen im Vergleich - Bestimmungskarten		Publishing house Quelle & Meyer, Wiebelsheim	

1.4.2 German names for galls

In Germany, many galls have a unique common name. The name describes the look of the gall, the place it is found, the host, or the gall former. For example, the pineapple-shaped galls of the spruce gall louse *Sacchiphantes abietis* are called

“Ananasgalle”, with means pineapple gall. The following table lists some galls and their German names, with the English translation or name (Table 2).

Table 2: Some examples of galls and their German names, with English translations.

Gall former: *Macrodiplosis pustularis* (Bremi 1847) **Order & Family:** Diptera: Cecidomyiidae **Host:** different *Quercus* species, for example, *Quercus petraea* (Lieblein 1784). **German name:** Blattlappengalle **English translation:** Leaf rag gall	 Figure 7: *Macrodiplosis pustularis* (Bremi 1847) galls on oak (Image credit: SMNS).
Gall former: *Neuroterus quercusbaccarum* (Linnaeus 1758) **Order & Family:** Hymenoptera: Cynipidae **Host:** different *Quercus* species, for example, *Quercus robur* L. **German name:** Große Linsengalle **English translation:** Big lentil gall	 Figure 8: *Neuroterus quercsbaccarum* (Linnaeus 1758) galls on oak (Image credit: SMNS).
Gall former: *Cynips divisa* (Hartig 1841) **Order & Family:** Hymenoptera: Cynipidae **Host:** different *Quercus* species, for example, *Quercus robur* L. **German name:** Braune Glanzgalle, Braune Eichenglanzgalle **English translation:** Brown shiny gall/ Brown shiny oak gall **English name:** Pea gall	 Figure 9: *Cynips divisa* (Hartig 1841) galls on an oak leaf (Image credit: SMNS).

Gall former: *Biorhiza pallida* (Olivier 1791) **Order & Family:** Hymenoptera: Cynipidae **Host:** different *Quercus* species, for example, *Quercus robur* L. **German name:** Schwammapfel **English translation:** Sponge apple	 Figure 10: Sponge apple gall from *Biorhiza palida* (Olivier 1791) (Image credit: SMNS).
Gall former: *Cynips longiventris* (Hartig 1840) **Host:** different *Quercus* species, for example, *Quercus robur* L. **German name:** Ziergalle/ Schmuckgalle **English translation:** Ornament gall/ Jewelry gall	 Figure 11: Ornament gall from *Cynips longiventris* (Hartig 1840) (Image credit: SMNS).
Gall former: *Neuroterus numismalis* (Geoffroy 1785) **Host:** different *Quercus* species, for example, *Quercus robur* L. **German name:** Seidenknopfgalle/ Münzgalle **English translation:** Silk button gall/ Coin gall **English name:** Silk button spangle gall	 Figure 12: Silk button spangle galls from *Neuroterus numismalis* (Geoffroy 1785) (Image credit: SMNS).

Gall former: *Taphrina betulina* (Rostrup 1883) **Host:** Betulaceae, for example, *Betula pendula* (Roth 1788). **German Name:** Hexenbesen **English translation/name:** Witch's broom	 Figure 13: Witch's broom on birch. (Image credit: Wikimedia Commons).
Gall former: *Diplolepis rosae* (Linnaeus 1758) **Host:** Rosaceae, for example, *Rosa canina* (Linnaeus 1753). **German name:** Rosenapfel, Schlafapfel, Rosenstengelgalle **English translation:** Roseapple, sleeping apple, rose stem gall **English name:** Robin's pincushion	 Figure 14: Robin's pincushion on wild roses (Image credit: SMNS).

1.5 Baden-Württemberg

This project is focused on the galls found in the state of Baden-Württemberg, Germany.

1.5.1 The ecology of Baden-Württemberg, its climate, and habitats

Figure 15: Map of Germany. Baden-Württemberg is located in the southwest (red). (Image credit: Wikimedia Commons).

Baden-Württemberg is located in the southwest of Germany (Figure 15). It is bordered by Switzerland to the south, Austria via Lake Constance, and France to the west. The German federal state of Reinland-Pfalz lies to the northwest, Hesse to the north, and Bavaria to the east. Baden-Württemberg is Germany's third largest federal state, with an area of 35.751 km² (State of Baden-Württemberg 2021).

Baden-Württemberg has a large area of low mountain range and has a transition from maritime to continental climate. Therefore, it has very distinctive seasons. The average yearly temperature of Baden-Württemberg is 8.1 °C (measured from 1961–1990). There are big regional differences. In the west of Baden-Württemberg, in the upper Rhine Valley, the average temperature is around 11 °C, which is quite warm. On the other hand, the average temperature is just around 4 °C in the Black Forest. In 2020, the average temperature in Baden-Württemberg was 10.2 °C which is around 2 °C warmer than normal and the second warmest year ever recorded in Baden-Württemberg (Zieher 2021, Bouras 2021).

The highest point in Baden-Württemberg is the Feldberg in the Black Forest, at 1493 m above sea level. The lowest point of Baden-Württemberg is in the Mannheim nature reserve Ballauf-Wilhelmswörth on the river bank of the Rhine. It is near the border of Hesse and is 87 m above sea level (State of Baden-Württemberg 2021).

Because of different layers of rock the impact of glaciers during the Ice Age, Baden-Württemberg offers an impressive variety of landscapes. Around 40 % of Baden-Württemberg is forest (State of Baden-Württemberg 2021).

Baden-Württemberg can be divided into three major landscape regions:

1) **Foothills of the Alps:** The foothills of the Alps include the Allgäu and Upper Swabia with their flat rolling hills. This also includes the largest lake in Baden-Württemberg, Lake Constance. The landscape of the Allgäu and Upper Swabia was carved by alpine glaciers and had a diverse landscape to offer. The landscape includes hills and hollows, lakes, wet meadows, and moors. At 14 km², the Wurzacher Ried is one of the largest intact raised bogs in Central Europe. The Federnsee with its reed zone also belongs here, as well as wet meadows in Upper Swabia (stork habitat) and the extinct Hegau volcanoes in the southwest of the region with heat-loving flora and fauna (Blessing 2014).

2) **Southwest German Scarplands:** A characteristic element of a stratified landscape is the change between steep slopes (stratified steps) and wide flat areas (stratified surfaces) (Südwestrundfunk & Westdeutscher Rundfunk 2021). The Southwest German Scarplands include the unique habitats of the Swabian Alps, the Black Forest, and the Odenwald. These are characterized by forests, towns, and agriculture (Westermann digital GmbH 2021).

   Swabian Alps: The Swabian Alps are a low mountain range. Flowery meadows and beech forests crisscross rocky slopes of the alpine ridge. Rocks and ridges rise out of the forest and provide refuges for flora and fauna. The Swabian Alps is home to juniper heaths and flower-rich calcareous meadows. Due to the silted-up Maarsee, the Swabian Alps has the Schopflocher high moor. At the southernmost edge of the Swabian Alps is the Swabian Canyon.

   Black Forest and Odenwald: Due to its north-south orientation, the Black Forest is a "rain catcher". In the low mountain range of the Black Forest is the Feldberg, the highest point in Baden-Württemberg. The Black Forest is one of the largest contiguous forest areas in Germany, with extensive mixed forests. Intact moors and swamps are typical for the northern Black Forest. Through livestock grazing, forest-free uplands are created. There are also wet heathland areas in the Black Forest. In the southern Black Forest, there are large forest areas. Due to the glaciers of the cold period, U-shaped valley sections with trough-like valleys and typical canyons can be found.

   The Odenwald is connected to the Black Forest by geological history. In the Odenwald, there are mountain landscapes with plenty of valleys. It changes into

the Buntstein Odenwald in the east with the highest dormant volcano (Katzenbuckel) in Baden-Württemberg. The Odenwald is divided by the Neckar river. In the southern part, there are wild forests and cliff areas with canyons (Blessing 2014).

3) **Rhine Rift Valley:** The Rhine Rift Vally is in the west of Baden-Württemberg. It includes the warm and sunny foothill zone with many vineyards but also the riparian forests of the Taubergiesen Nature Reserve. It also includes the Kaiserstuhl, an extinct volcanic region that is home to heat-loving flora and fauna (Blessing 2014).

1.5.2 Galls of Baden-Württemberg

Much is known about galls in Germany. However, this knowledge is often limited to smaller areas. More is known about some locations, less about others. Detailed checklists for individual states do not exist. There are many private collections, but much of their data have not been published.

There is no complete checklist of the galls of Baden-Württemberg. However, some checklists include parts of the state or parts of the fauna. Pfützenreiter & Weidner (1958) published a list of oak galls in the Favoritenpark of Ludwigsburg, Baden-Württemberg. Huber (1975) published a checklist of galls in Swabia, which is part of Baden-Württemberg and Bavaria. Skuhrava et al. (2014) published a book on the gall-forming Cecidomyiidae of Germany. This includes a checklist of German Cecidomyiidae by state, including Baden-Württemberg. However, the checklist is not complete because there is not much information available for every state, and not much is known about the distribution of galls in general. The German Mycological Society published detailed distribution checklists of fungi in Germany, including extra checklists for all federal states. The checklist for Baden-Württemberg includes 5896 species of fungi (Thines 2021). Gall-inducing fungi are not specifically indicated, but the distribution of known species can be checked.

1.6 Databasing and digitization

Museum digitization is very important. Backing up all data in the digital collection is necessary not only for a better overview but also as a backup in case the objects are

lost or destroyed. For example, many museum artifacts were destroyed in World War II (Naturkundemuseum Berlin 2021). More recently, in Rio de Janeiro, the National Museum of Brazil, with more than 20 million scientific objects, was largely destroyed by a fire in September 2018 (Ring 2018).

Label data, georeference points, and a high-resolution image should be digitized. The locality information can provide perspectives on the diversity and distribution of a given taxon. Locality data can be cross-referenced with historical data such as temperature to understand changes over time. Image data can be used for morphological studies (Hedrick et al. 2020, Carnegie Museum 2019).

Digitizing museum objects and making images available on the Internet makes the museum collection easy to find. Researchers can find specimens of interest. This is useful because researchers do not have to come in person for research. In turn, less handling prevents damage to delicate specimens. Not only does this make scientific research easier, but it improves the international reputation of the collection (Hedrick et al. 2020).

Digitization of museums does not make physical specimens less important. Digitization makes them more visible and even more valuable (Carnegie Museum 2019).

1.7 Objectives and hypotheses

The primary objective of this study was to explore the scientific potential of the SMNS gall collection concerning the gall-forming fauna of Baden-Württemberg. The secondary objectives were:

1. Curate and catalog the SMNS gall specimens from Baden-Württemberg.
2. Describe and evaluate the gall curation and storage methods found in the collection.
3. Database and digitize the gall specimens from Baden-Württemberg.
4. Use the collection as a basis for public outreach centered around local galls.
5. Compile the first checklist of gall formers of Baden-Württemberg.

Based on the newly compiled checklist, it was hypothesized that the arthropod diversity within the gall collection at SMNS would reflect the known arthropod gall diversity of Baden-Württemberg.

2. Materials and Methods

2.1 Materials

2.1.1 Databasing and digitization

All information from the galls of the SMNS were cataloged by Microsoft Excel and the database program Diversity Workbench. To check the taxonomic nomenclature, the websites “Gbif” (Global Biodiversity Information Facility 2021), “Catalogue of life” (Catalogue of life 2021), and “Plant Parasites of Europe” (Ellis 2021) were used.

The freezer “Liebherr Mediline” (-20 °C) was used to quarantine the SMNS gall collection for digitization in the SMNS herbarium.

Digitization scale bar, white balance, and color palette were used for the photo session of the galls. The herbarium digitization imaging program is “Capture One DB 11” (Capture One 2021). The camera model “Credo 80” from “Leaf” was used for the digitization.

2.1.2 Gall checklist for Baden-Württemberg

For the gall checklist, the program Microsoft Excel was used. Using the SMNS entomology collection, literature, and the unpublished private gall checklist by Margot and Roland Spohn, the first gall checklist of Baden-Württemberg was created.

2.1.3 Public outreach

The blog articles were written by using the Microsoft Word program and the Word Press program for blogs. The information in the blog article was collected using references like the book from Küster (1911) and the nature guide by Bellmann et al. (2018). For social media, the account @mermaidkathi (Mertz 2021) was used. The Blog Nixenzauber (Mert & Mört 2021) and SMNS Science Blog (Schmid & Schubert 2021) were used for public outreach.

2.2 Methods

2.2.1 Study area

The study area of this project is Baden-Württemberg, Germany. For the project, only galls from the federal state of Baden-Württemberg were used. Galls from other parts of Germany or other countries were not considered.

2.2.2 Galls in the SMNS Entomology Collection

There are many galls stored in the entomological collection of the SMNS. Over the years, the SMNS has received galls from all over the world. The galls are from private collectors or scientists who worked in the museum or sent their collected galls to Stuttgart. The galls were collected over the last 200 years.

In the entomology collection of the SMNS, the galls have a separate storage place (4 large cabinets). The storage type of galls is variable. There does not seem to be a uniform storage method. The galls are on single herbarium sheets, envelopes, notebooks, file folders, cardboard boxes, or pinned in insect drawers.

The galls in the SMNS are usually not cataloged or otherwise documented. The last curation was in 1995 by Prof. Edwin Möhn (1928–2008), who was an entomologist and gall-midge taxonomist, chief curator at the SMNS, and professor of biology at the University of Stuttgart. However, not all galls were examined.

Besides the large cabinets, there are other galls in the entomological collection. Some galls can be found in the personal collection of the German entomologist Karl Ludwig Friedrich von Roser (1787–1861). Roser is co-founder of the “Verein für vaterländische Naturkunde”, established 1844. Entomology was his hobby. Because of his father, he studied law, and later, he was a high-ranking government official and administrator in the Kingdom of Württemberg. His collection was donated by his grandchildren to the “Verein für vaterländische Naturkunde” in 1872 to be transferred into the Museum's ownership (Schüz & Harde 1963). The real age of his collection is unknown.

Additionally, some galls are pinned in the SMNS dry insect collection next to the insects that emerged from them.

2.2.2.1 Sorting and accessioning

For this project, all the galls from the four cabinets were reviewed, and those collected in Baden-Württemberg were chosen. All of the chosen galls were assembled into a new, separate collection. Galls from the von Roser collection or in the insect collection remained in their place and were not included in the new collection.

Accession numbers were given to the nearly 400 samples: SMNS_Ent_Gall_000001 to SMNS_Ent_Gall_000395. A new range was created for the Diversity Workbench (DWB) (Triebel et al. 1999). For a better overview, the samples were accessioned in order by date of collection. At a later stage, a few specimens were added.

The storage method was not changed. Many hosts or galls are not determined yet. These were also accessioned.

2.2.2.2 Identification of hosts and gall formers

The collectors themselves made the identification of the galls and host species. Some identifications were verified later by experts and employees of the museum, like Dr. Oskar Klement (1897–1980), a German lichenologist who was also interested in galls.

However, many taxonomic names were outdated, so all had to be reviewed and converted to today's correct nomenclature. Synonyms and old names were transferred to the current valid species names during the current project.

For the current taxonomy, the websites “Global Biodiversity Information Facility” (Global Biodiversity Information Facility 2021), “Plant Parasites of Europe” (Ellis 2021), and “Catalogue of Life” (Catalogue of life 2021) were used. Valid names were recorded under the collection number given in the DWB. Specimens have not yet been relabeled in the collection.

A few galls were identified using Bellmann et al. (2018) and other galls from the collection for reference as part of this research. However, a detailed determination of all species could not be done within this project's scope, so many galls or hosts remain to be identified. In the DWB, these are identified only as "Gallen" (galls).

2.2.2.3 Phenology and biodiversity

From the specimen labels, information was collected about the taxonomic diversity of the galls and their hosts. If different gall species occurred on the host, they were considered as multiple records. The total number of galls is 490 with 394 accession numbers.

For information about penology, all galls were checked for the collection date. Collection dates were analyzed by month and year. The different types of galls were counted even if they were collected on the same day and assigned to one specimen. Therefore 474 collecting dates with 394 accession numbers are present. Sixteen specimens had no information about the collecting month.

2.2.2.4 Distribution maps

To get an idea of which parts of Baden-Württemberg are well-represented in the SMNS gall collection, a map was created using the DWB. The georeference and TK25 information for all specimens were added. The map was made using the Spreadsheet function TK25 within the Grid function.

To make an overview map of the collection places, the columns “note”, “year”, “country cache”, and “average year” were added by column “Event”. The symbols, colors, evaluation, and map by using the option “symbols for the maps” in the top bar were set.

Symbols: In symbols, “Event” for table was chosen and country cache as column. The size and the symbol (a black dot) were added.

Colors: No extra colors were set.

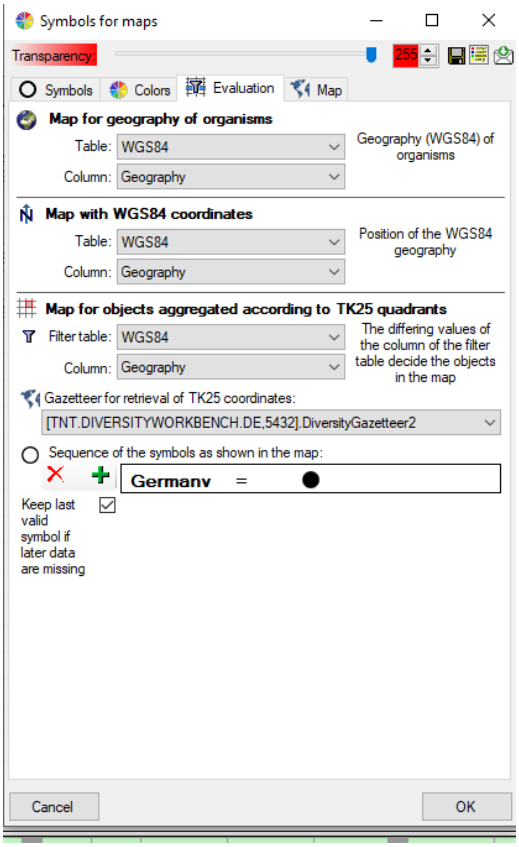

Figure 16: Mapping function in the DWB. The setting „Symbols for maps” is shown, along with the option “Evaluation” (Image credit: DWB).

Evaluation: WGS84 and Geography are used for all three options. The black dots for country were added (Figure 18).

Map: A georeferenced map of Baden-Württemberg was used. The map was shown by WGS84.

Settings: "No frame" and "Make a screenshot of the map" were chosen. The map can be exported as an image file by using the option “Save your file”.

2.2.2.5 Databasing

All available specimen data was recorded in the DWB. Specimen data included all available taxonomic information on gall former and host. Unidentified galls were also included. Other data included collection date, locality, and collector. (Figure 17).

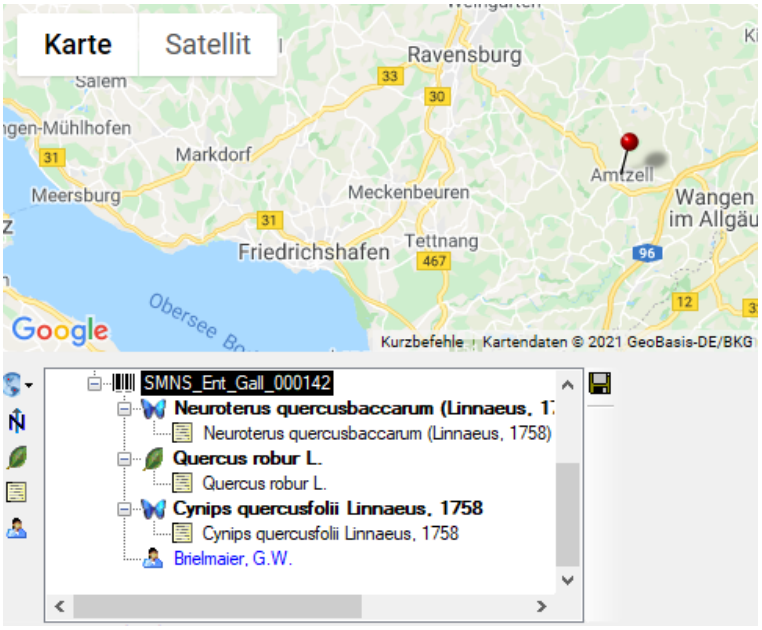

Figure 17: Screenshot of specimen SMNS_Ent_Gall_000142 in the Diversity Workbench. Two different species of galls were found. *Neuroterus quercusbaccarum* Linneaus 1758 and *Cynips quercusfolii* Linneaeus, 1758 The host is *Quercus robur* L. The collector is Brielmaier. The galls were found near Amtzell (Image credit: DWB).

Further information, if available, was also added. All information for each specimen is associated with a unique accession number in the DWB. A new range of CUIDs, “SMNS_Ent_Gall_*” was created for this project.

For the collection locality, GPS coordinates were guessed based on label data and shown on the map in the DWB. Usually, only an approximate area could be given and not an exact location. Very few specimens had GPS coordinates on the label.

2.2.2.6 Digitization

Sixty-eight specimens were digitized. Only completely identified species were chosen, and no duplicate species were photographed. For each species with multiple specimens, the specimen with the most beautiful and clearly visible galls were selected. Digitization occurred in the SMNS herbarium in March 2021. The galls were taken from the entomological collection, and after a quarantine time of two weeks in the freezer at -20°C, they were brought to the herbarium. The quarantine made sure that no living parasites came to the herbarium.

In the herbarium, selected specimens were professionally photographed with the help of botanical preparator Christiane Dalitz. The Capture One DB 11.3 program was used for editing and preparation. The camera was a Leaf Credo 80. Settings were as follows: aperture F/11; exposure time 1/8 sec; ISO film speed ISO-50; focal length 120 mm; metering mode: center-weighted.

For digitization, the gall specimen was placed on a neutral base along with its accession number and specimen label. A color palette, a white balance for color matching, and a scale bar were included (Figure 18).

Figure 18: Digitization layout, including scale bar (size reference), specimen data, and accession number (Image credit: SMNS).

Images were cropped, and the white balance was adjusted. Each file was named for its accession number. The photos were added to the DWB and made publicly available for scientific research.

2.2.3 Checklist of galls of Baden-Württemberg

To create a checklist of galls in Baden-Württemberg, the first step was to examine the newly designated "Galls of Baden-Württemberg" collection in the SMNS. Next, all known species from Baden-Württemberg found in the SMNS were added.

The Cecidomyiidae from the checklist of gall midges of Germany (Skuhrava et al. 2014) were added. For further additions, the checklist "Pflanzengallen Schwabens" (Huber 1975) was examined. Swabia is an area that includes parts of Baden-Württemberg and Bavaria. All localities where the galls were found were checked, and those found in Baden-Württemberg were added.

An additional reference was provided by the paper of Pfützenreiter & Weidner (1958), which contains a checklist of the oak galls in the Favoritenpark Ludwigsburg.

Figure 19: *Kiefferia pericarpiicola* (Bremi 1847) on *Daucus carota subsp. carota* L.. Found in the south of Ehningen (48°39'16.7"N 8°57'07.9"E) during the nature observations.

Through nature excursions around Stuttgart, 21 species could be verified or added to the new Baden-Württemberg gall checklist, for example, *Kiefferia pericapiicola* (Figure 19). Plants were identified to family or genus according to Schauer & Caspari (1990), as well as the “PlantNet” application (Pl@ntNet 2013).

Galls were identified following Bellmann et al. (2018). The identification was done by Ronja Reinisch and Ann-Kathrin Mertz.

There is a gall database on Buhr's website with verification photos of about 2500 galls (Buhr 2007). The images include information about the gall former and host as well as the location of the galls. As part of the project, all photos were reviewed, and those species from Baden-Württemberg were added to the gall checklist.

Furthermore, to extend the gall checklist of Baden-Württemberg, contact was made with the gall experts Margot and Roland Spohn, who live in Baden-Württemberg. The two researchers were able to add about 100 more species to the checklist of galls in Baden-Württemberg with their unpublished observations.

Coleopteran galls from Bellmann et al. (2018) were compared with the species checklists of Baden-Württemberg, and eight additional coleopteran species were added for the galls checklist. Six species were added from Harmunth et al. (1999).

The website of the German Mycological Society has a checklist of fungus species in Germany with distribution maps (Thines 2021). All orders where a gall-forming fungus was already on the checklist were checked for distribution in Baden-Württemberg by means of this website. These species were checked for “gall-status” via the "Plant Parasite of Europe" website (Ellis 2021). Any gall-forming fungi from Baden-Württemberg were added to the gall checklist.

All inventory records were standardized to recent taxonomies. The websites “GBIF” (Global Biodiversity Information Facility 2021), “Catalogue of Life” (Catalogue of life 2021), and “Plant Parasites of Europe” (Ellis 2021) were used.

The first gall checklist of Baden-Württemberg (Table 10, Appendix) was made with all this information. The checklist includes gall former species, family, order, kingdom, the first describer, and the host. All species on the checklist were checked by their occurrence in Baden-Württemberg.

2.2.4 Public outreach

To bring galls closer to the public, a German-language blog article was written on the topic of galls. Many people from the German-speaking population are not familiar with the term galls because these are rarely explained in school or books. However, many have noticed the outgrowths on leaves. The blog article aims to explain to the public what galls are and how they can be found in nature. Simple explanations and photos should make the reader sensitive to the galls so that they can be more aware of them and share their knowledge. The blog article is intended to help ensure that knowledge about galls is not lost.

Besides the explanations of what galls are, how they look, and where they can be found, a little historical background is mentioned. The German article about galls is published by the Nixenzauber blog (Mertz & Mört 2021) and will be published by the SMNS Science Blog (Schmid & Schubert 2021, Figure 20).

Figure 20: The look of the SMNS Science Blog (Schmid & Schubert 2021). The blog has articles about museum research behind the scenes (Image credit: SMNS).

The text of the German-language blog article was written at a simple level so that children, teenagers, and adults could read and understand it without any problems. According to the target audience, two different versions of the blog article were produced. The target audience of the blog Nixenzauber (Mertz & Mört 2021) refers more to children, teenagers, and "non-scientifically interested" adults, while the article on the SMNS Science Blog (Schmid & Schubert 2021) is aimed at scientifically interested adults.

The blog article on the blog Nixenzauber (Mertz & Mört 2021, Figure 21) includes two links to the author's reviews of books with galls. The reviews are about the nature guide book „Faszinierende Pflanzengallen“ (Bellmann et al. 2018) and the children's nature book „Die wunderbare Welt der Eichen“ (The Amazing World of the Oak, Müller 2020), which has beautiful oak gall illustrations.

Figure 21: The look of the Nixenzauber Blog (Mertz & Mört 2021). The blog includes articles about German books and about mermaiding (Image credit: Mertz & Mört).

Information about galls was also shared on various social media sites. For example, photos from gall collecting excursions were posted on Instagram.

3. Results

3.1 The SMNS gall collection

Three hundred and ninety-five accession numbers were databased in the DWB. Photographs of 68 specimens were added.

3.1.1 Age and history of specimens

All galls of Baden-Württemberg were collected over the years by independent collectors, scientists, or employees of the SMNS (Table 3).

Table 3: SMNS gall collectors by time period.

Years of collection	1909 to 1917	1919, 1929, 1930, 1932	1955 to 1968	1970 to 1974	1986
Number of gall species	26	4	190	230	40
Collectors	Otto Jaap	P. Maag	Pfützenreiter, Brielmaier, Failer, Bächtle, Heer, Endele, Raible, Georgii	Brielmaier, Antonio Wünsch, Stiefel, Prof. Möhn	T. Breunig, I. Wunderle, A. Grams

The oldest galls were collected in the 19th century and are from the Stuttgart region. These galls are in the collection of Karl von Roser. His collection age is between 160 and 220 years. The collection information is unknown (Schüz & Harde 1963, Schmid et al. 1998). Three insect drawers from this collection, each containing numerous different galls and insects, were given the accession numbers "Gallen 001", “Gallen 002", and "Gallen 003". They were not databased in the DWB due to the large number and variety of specimens in each drawer. Not only are there many different species, but there is also no collection data for the samples. Their approximate age and origin are inferred from the life history of von Roser.

In the DWB, the galls of Otto Jaap's (1864–1922, German teacher, botanist, and entomologist) collection were included. The galls date from the early 20th century. In 1909, 1913, and 1917 he collected 26 galls in Baden-Württemberg, which are in the SMNS.

The collection contains one specimen each from 1919, 1920, 1930, and 1932. P. Maag collected all four galls.

Between 1955 and 1968, 190 galls were collected, mainly by Dr. Franz Pfützenreiter (1888–1969, employee of Württembergische Landesstelle for Nature Conservation and Landscape Management) and Georg Wolfgang Brielmaier (1912–1975, botanist). Other galls from this time period were collected by W. Bächtle, Dr. W. Endele, Failer, Georgii, Heer and Veronika/Monika Raible.

In the early 1970s, biology teacher Antonio Wünsch collected galls for his thesis project. These galls are in the collection. Other galls were collected by Stiefel, Grams, Enders, and Prof. Dr. Edwin Möhn.

In the 1980s, specimens collected by Thomas Breunig, Wunderle, and Grams were deposited in the SMNS gall collection. For unknown reasons, 1986 was an especially prolific year for gall collecting, with 40 specimens.

3.1.2 Phenology

Galls were collected throughout the year. However, most were collected in August (142 galls) and September (141 galls). The third most collected month was October, with 69 galls. There were a total number of 474 collecting dates with 395 accession numbers in the collection. Seventeen specimens had no information about the collection month. Most galls were collected in summer and fall (Figure 22).

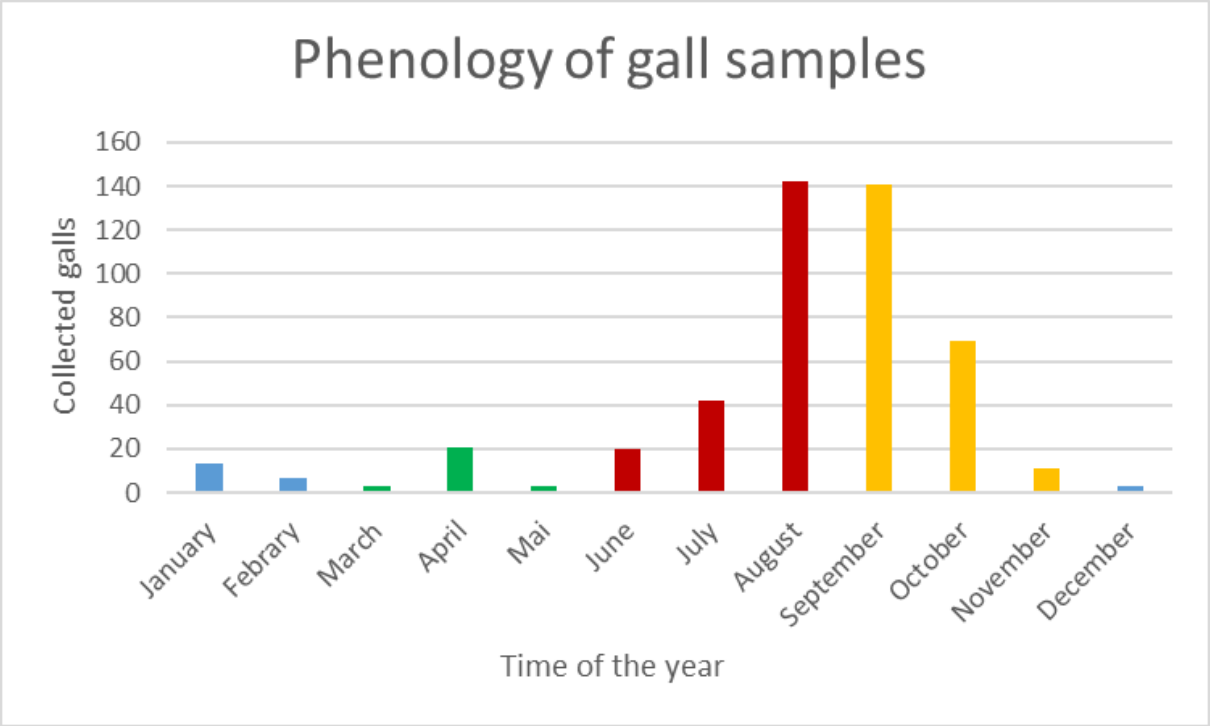

Figure 22: Phenology of gall samples. The bar chart shows how many galls are collected in different months. Most galls were collected in August and September. Blue represents winter, green is spring, red is summer, and yellow is fall.

3.1.3 Gall formers in the collection

In the SMNS gall collection, there are 490 galls with 394 accession numbers. Three hundred and fifty-eight specimens are identified to species. Ninety-five different gall species are identified in the SMNS gall collection. Many species are represented by multiple specimens. There are 142 galls with no species identification (Figure 23).

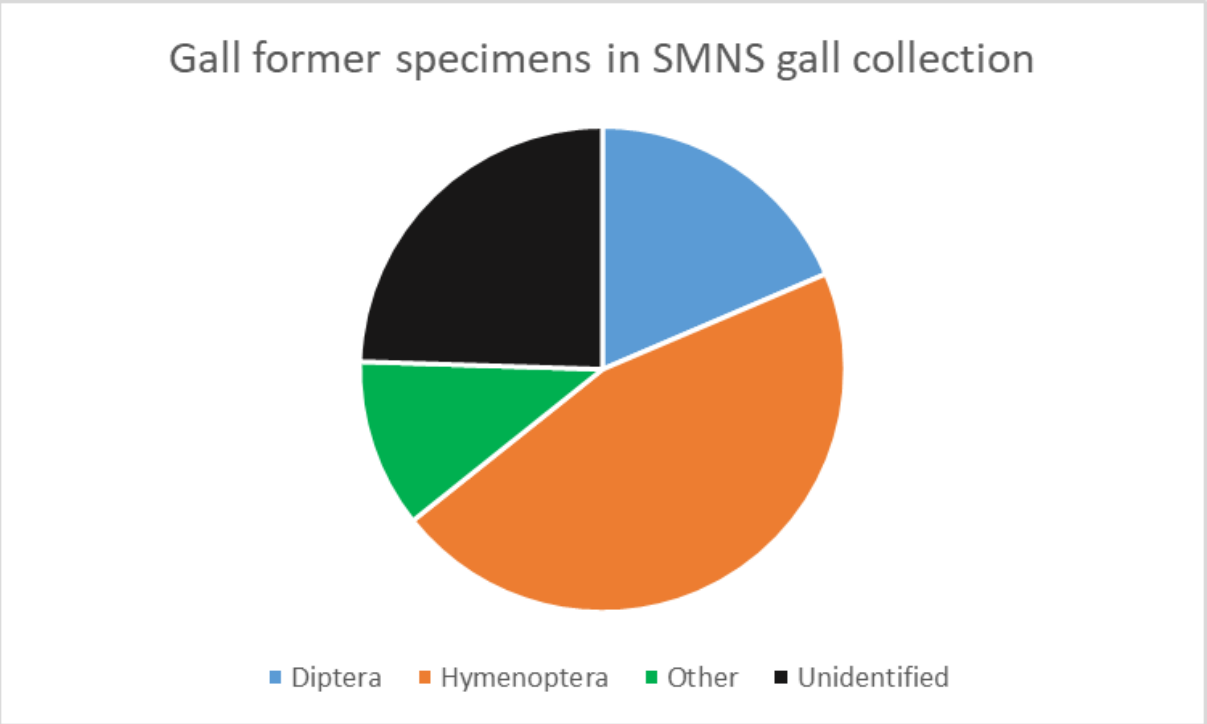

Figure 23: Gall formers in the SMNS from Baden-Württemberg by order and number of specimens. “Other” includes other animals, bacteria, plant and fungi).

There are 370 galls identified to order. Of these, 224 galls are Hymenoptera, and 91 are Diptera. Other orders, including bacteria, fungi, and plants, are represented by 55 galls. No order identification is provided for 120 galls (Table 4).

Table 4: Gall former orders in the SMNS gall collection, by the number of specimens and species.

Gall former order	Number of specimens	Number of species
Hymenoptera	224	33
Diptera	91	25
Other	55	37
unidentified	120	-

3.1.3.1 Hymenoptera

In the SMNS gall collection, 33 different species of gall-forming Hymenoptera could be identified: 31 Cynipidae and 2 Tenthredinidae. A checklist of gall-forming Hymenoptera

for Baden-Württemberg does not exist yet. Twenty-three of the species in the collection are published as occurring in Baden-Württemberg (Pfützenreiter & Weidner 1958, Huber 1975). Eight species from the collection have not been previously recorded for Baden-Württemberg (Table 5).

Table 5: Eight new records of Hymenoptera species for Baden-Württemberg.

Family	Species	Author
Cynipidae	*Aulacidea hieracii*	Bouché 1834
Cynipidae	*Cynips agama*	Hartig 1840
Cynipidae	*Diastrophus rubi*	Bouché 1834
Cynipidae	*Diplolepis nervosa*	Curtis 1838
Cynipidae	*Phanacis centcuerae*	Förster 1860
Cynipidae	*Euura viminalis*	Linnaeus 1758
Cynipidae	*Xestophanes potentillae*	De Geer 1783
Tenthredinidae	*Pontania pedunculi*	Hartig 1837

3.1.3.2 Diptera

In the SMNS gall collection, 26 Diptera species could be identified. Skuhrava et al. (2014) lists 139 species for Baden-Württemberg. Twenty-one species from the SMNS collection were already listed in Skuhrava et al. (2014). One additional species from the SMNS belongs to the family Tephritidae. Four cecidomyiid species found in the museum collection were previously unrecorded from Baden-Württemberg (Table 6).

Table 6: Four new records for Diptera species for Baden-Württemberg.

Family	Species	Author
Cecidomyiidae	*Rabdophaga albipennis*	Loew 1850
Cecidomyiidae	*Rabdophaga degeerii*	Bremi 1847
Cecidomyiidae	*Rabdophaga heterobia*	Loew 1850
Cecidomyiidae	*Rabdophaga terminalis*	Loew 1850

3.1.3.3 Other gall-forming organisms

Two gall-forming species of Coleoptera were found: *Gymnetron villosulum* and *Bostrichus kaltenbachi*, both in the Curculionidae. Gall-forming Lepidoptera were not identified in the collection.

In the order of Hemiptera, 23 species were found from 7 families, with ten species not forming galls. Besides the insects, other galls were found in the SMNS gall collection. In the mite order Trombidiformes, eight species are found in the collection. Four species are found in the kingdom of fungi: 2 in the order Exobasidiales and one each in the order Taphrinaceae and Pucciniales. One bacterial species is present in the SMNS gall collection: *Agrobacterium tumefaciens* from the order Rhizobiales. There is one gall-forming species from the plant kingdom: *Viscum album.*

Four species are not yet listed specifically for Baden-Württemberg (Table 7).

Table 7: Four new records of other gall-inducing organisms for Baden-Württemberg.

Family	Species	Author
Aphididae	*Aphis symphyti*	Schrank 1801
Psyllidae	*Livia junci*	Schrank 1789
Adelgidae	*Adelges abietis*	Linnaeus 1758
Adelgidae	*Adelges viridis*	Ratzeburg 1843

3.1.3.4 Non-gall species

Most scale insects do not form galls but look like a gall themselves and are therefore preserved alongside true galls. In the SMNS gall collection, there are ten such species. They belong to the families of Diaspididae and Coccidae. Because they do not form galls, these ten species are not included in the checklist.

3.1.4 Gall hosts in the collection

Galls are always collected together with a part of their host. The determination of the hosts helps with the determination of the gall former. In the collections, nearly all of the galls were found on plant hosts. Just two specimens were found on Polyporaceae (fungi). Hosts belonged to 27 orders (26 plant orders and one fungus). Fifty-two specimens had an unidentified host. One hundred and twenty-eight are not identified by species, but order and family and sometimes genus are known.

The most frequently represented host order is Fagales (206), to which *Quercus* (198) belongs. The next most common order is Salicales (148), to which *Salix* belongs. In the order Rosales, there are 18 specimens, and in the order Coniferales, there are 14 specimens. In the other 23 orders, only a few specimens (1–6) were found. If different gall species occurred on the plant, they were considered as multiple records. The total number of galls is 492 with 394 accession numbers (Figure 24).

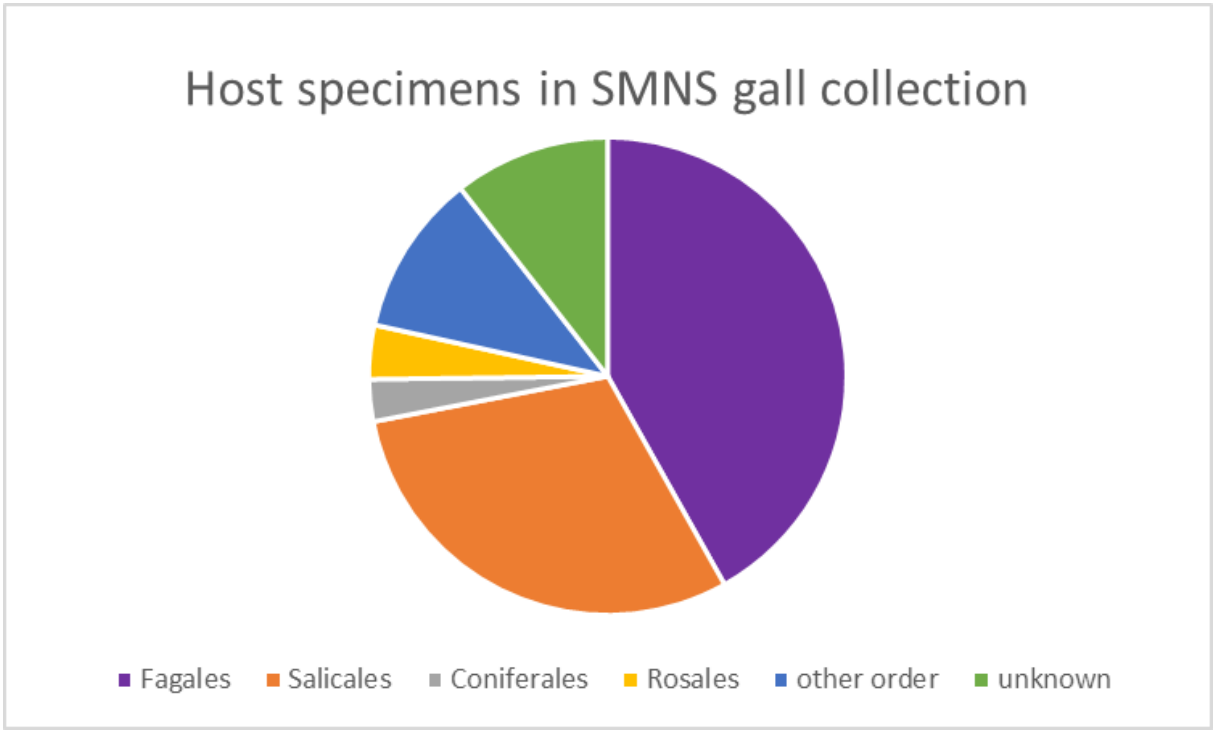

Figure 24: Number of gall specimens by host order. Many hosts belong to the same species. Within the Fagales most plant specimens were found (purple). Unknown includes 52 unidentified plants and one unidentified fungus.

Only 312 hosts were identified to species. In total, 90 different species represent 27 orders in the SMNS gall collection (Table 8).

Table 8: Overview of host order by the number of specimens and species in the SMNS gall collection.

Host order	Specimens in the new SMNS gall collection	Different species in the SMNS gall collection
Fagales	206	7
Salicales	148	25
Coniferales	14	7
Rosales	18	11
other order (23)	54	40
unknown	52	-

3.1.5 Unidentified material

There is much unidentified material in the SMNS. One hundred and forty-two gall specimens from the collection are not identified, and it is unclear what kind of galls they are. In 9 specimens, the label reveals that they are Hymenoptera, five are Acari, one is the gall of an Aphidoidea (Hemiptera), and one is from a fungus. No other information could be found.

For hosts, 52 are completely unidentified, and 128 other specimens have not been determined to species but are identified to genus or family.

3.1.6 Distribution maps

The distribution map shows the study area of Baden-Württemberg in the southwest of Germany. The dots show the approximate locations where the galls were collected (Figure 25).

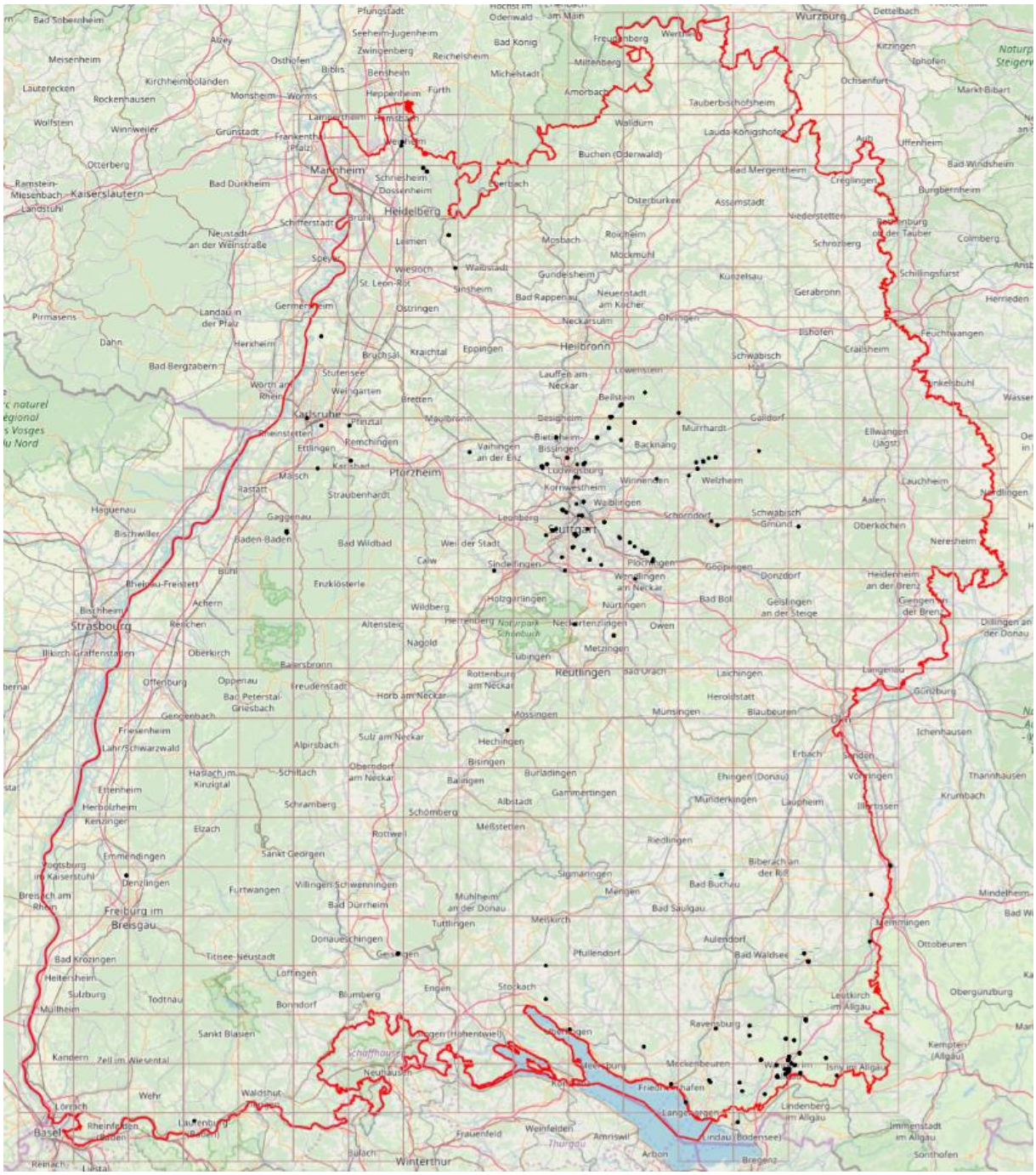

Figure 25: Distribution map of galls in the SMNS gall collection (Image credit: DWB).

Many galls were collected in the area around Stuttgart and the western Allgäu down to Lake Constance. In addition, a few were scattered in other regions of Baden-Württemberg. Many regions of Baden-Württemberg are not sampled.

Remarkably, no specimens were collected from the Black Forest or the Swabian Alb. These interesting ecological areas seem to have been neglected by the gall collectors.

Because the SMNS is located in Stuttgart, the Stuttgart area was more closely studied. Out of 395 in the collection, 120, or about 30 %, were collected in the Stuttgart area (Figure 26).

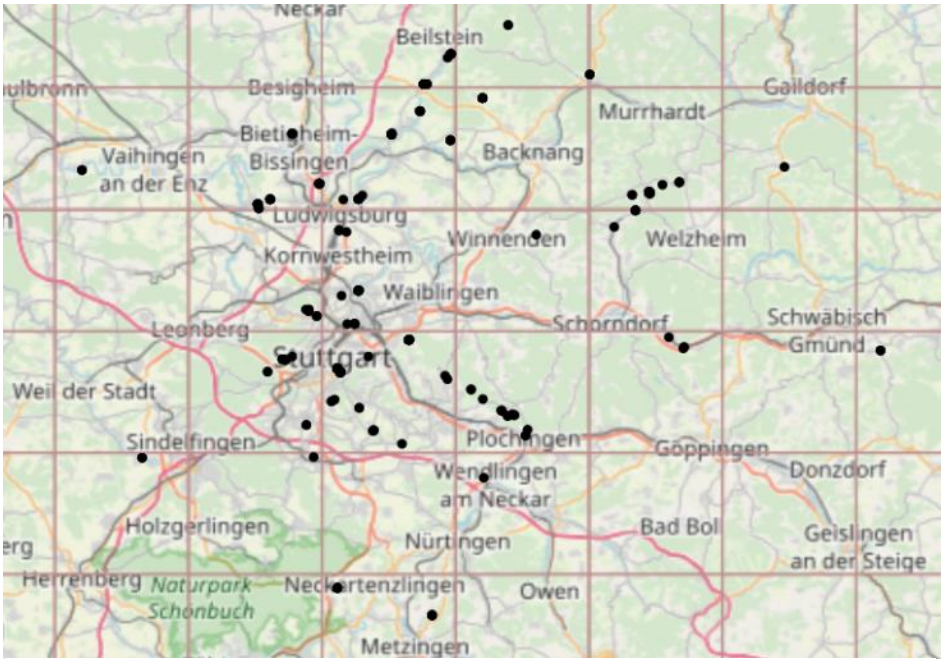

Figure 26: Stuttgart area distribution map of the galls in the SMNS gall collection. 120 accession numbers are found in this area (Image credit: DWB).

3.1.7 Digitization

A total of 68 specimens were digitized. Photographs are part of the specimen record in the DWB. For 21 specimens, two photographs were taken to capture better detail. The first image (Figure 27) contains the specimen, the label, the association number, the scale bar, and "Color-Checker".

Figure 27: Digitization. First image of the gall specimen SMNS_Ent_Gall_000099 including the label, the accession number, the scale bar and "Color-Checker" (Image credit: SMNS).

The second image (Figure 28) shows the gall in higher magnification without the label.

Figure 28: Digitization. Second image of the gall specimen SMNS_Ent_Gall_0000099. The specimen is in higher magnification. The accession number, the scale bar, and "Color-Checker" are also seen in the picture. The label is not included in the second image (Image credit: SMNS).

3.1.8 Storage methods

Six different storage methods can be found in the SMNS gall collection.

Envelopes: Many galls are in envelopes (Figure 29). These can be premade envelopes or envelopes made of folded paper. Another kind of envelope storage places the label and the specimen into an envelope made of transparent film material.

Figure 29: Three different kinds of envelope storage. Left: clear envelope. Middle: folded paper. Right: premade envelope.

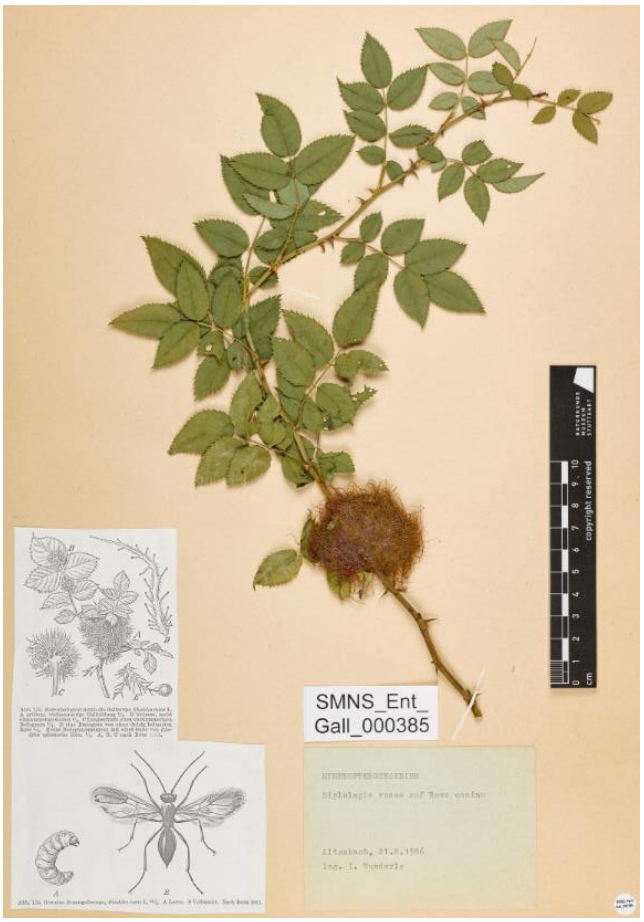

Figure 30: Herbarium sheet by T. Breunig. The specimen shows wild rose with a *Diplolepis* gall and includes illustrations, which is rather unusual (Image credit: SMNS).

Herbarium sheets: Another method of storage of the collection are herbarium sheets (Figure 30). Like typical herbarium specimens, the hosts are glued together with galls on a paper sheet and labeled.

Figure 31: “Notebook” with galls by Antonio Wünsch.

“Notebook”: The galls collected for Wünsch’s thesis are stored as a “notebook” (Figure 31). Like the herbarium sheets, the dried host and the gall are glued on paper. The sheets were combined into a book. This is an unusual storage method and seems to be unique to the thesis of Antonio Wünsch.

Clear plastic folders: Folders with galls and labels are filed in a ring binder. Similar to the “notebook”, each folder must be flipped to see the specimens on the next page (Figure 32).


Figure 32: Clear plastic folders filed in a ring binder.

Boxes: Some galls were stored in small cardboard boxes (Figure 33). The galls can be seen immediately if there is no lid or if the lid is transparent.

Figure 33: Host (fungi, Polyporales) and unidentified gall inside a little cardboard box.

Insect drawers: The oldest galls from Baden-Württemberg are pinned in insect drawers from the von Roser collection (Figure 34).

Figure 34: Different galls are pinned in an insect drawer together with insects (Image credit: SMNS).

3.2 Checklist of galls of Baden-Württemberg

A total of 890 gall species can be found on the newly compiled checklist of Baden-Württemberg (Table 10, Appendix). In the checklist, there are 375 species from the animal kingdom (of which 371 species are arthropods), six species from the bacterial kingdom, 507 species from the fungal kingdom, and two species from the plant kingdom.

The checklist "Pflanzengallen Schwabens" (Huber 1975) provided 59 species records. This work included *Trioza urticae*, which is not included in the new checklist. It is not a gall, according to "Plant Parasites of Europe" (Ellis 2021).

The checklist of oak galls of Ludwigsburg "Die Eichengallen im Naturschutzgebiet Favoritepark in Ludwigsburg und ihre Bewohner" (Pfützenreiter & Weidner 1958) provided 40 species records.

From Skuhrava et al. (2014), 135 species were added for Baden-Württemberg. Another four species from this paper were removed from the checklist because they are not galls, according to "Plant Parasites of Europe" (Ellis 2021). However, of these 135 species, four species are also on the checklist of Pfützenreiter & Weidner (1958) and five on Huber's checklist (1975).

All 890 species are already listed for Germany. One hundred and five species are new records for Baden-Württemberg. This includes 97 arthropods (30 Diptera, 29 Hemiptera, 22 Hymenoptera, 16 Acari), three bacteria, and five fungi.

3.2.1 Removed species

Twenty-six species are not gall formers. According to Ellis (2021), five species form leaf mines, and 19 are simply plant parasites. Among them are also ten species that are in the SMNS gall collection. The remaining 16 are found on other gall checklists. The species are all from the kingdom Animalia and were also found in Baden-Württemberg (Table 9).

Table 9: Non-galling species. Of these 26 species, 10 are part of the SMNS gall collection.

Order	Family	Species	Author	
Diptera	Anthomyiidae	*Chirosia betuleti*	Ringdahl 1935	Mine
Diptera	Cecidomyiidae	*Cystiphora sanguinea*	Bremi 1847	Mine
Diptera	Cecidomyiidae	*Cystiphora taraxaci*	Kieffer 1888	Mine
Diptera	Cecidomyiidae	*Gonioctena pallida*	Linnaeus 1758	Mine
Diptera	Cecidomyiidae	*Monarthropalpus flavus*	Schrank 1776	Mine
Diptera	Cecidomyiidae	*Planetella cucullata*	Meigen 1818	Parasite
Diptera	Cecidomyiidae	*Resseliella quercivora*	Mamaev 1965	Parasite
Diptera	Cecidomyiidae	*Xylodiplosis nigritarsis*	Zetterstedt 1850	Parasite
Hemiptera	Coccidae	*Aonidia lauri*	Bouché 1833	Parasite
Hemiptera	Coccidae	*Coccus hesperidum*	Linnaeus 1758	Parasite
Hemiptera	Coccidae	*Coccus phalaridis*	Linnaeus, 1758	Parasite
Hemiptera	Coccidae	*Coccus viridis*	Green 1889	Parasite
Hemiptera	Coccidae	*Parthenolecanium corni*	Bouché 1844	Parasite
Hemiptera	Coccidae	*Parthenolecanium rufulum*	Cockerell 1903	Parasite
Hemiptera	Coccidae	*Physokermes piceae*	Schrank 1801	Parasite
Hemiptera	Coccidae	*Pulvinaria salicis*	Bouché 1851	Parasite
Hemiptera	Coccidae	*Saissetia coffeae*	Walker 1852	Parasite
Hemiptera	Diaspididae	*Aspidiotus nerii*	Bouché1833	Parasite
Hemiptera	Diaspididae	*Aulacaspis rosae*	Bouché 1833	Parasite
Hemiptera	Diaspididae	*Carulaspis juniperi*	Bouché 1851	Parasite
Hemiptera	Diaspididae	*Diaspidiotus ostreaeformis*	Curtis 1843	Parasite
Hemiptera	Diaspididae	*Diaspis boisduvalii*	Signoret 1869	Parasite
Hemiptera	Diaspididae	*Dynaspidiotus abietis*	Schrank 1776	Parasite
Hemiptera	Diaspididae	*Lepidosaphes ulmi*	Linnaeus 1758	Parasite
Hemiptera	Liviidae	*Orthezia urticae*	Linnaeus 1758	Parasite
Hemiptera	Triozidae	*Trioza urticae*	Linnaeus 1758	Parasite

3.3 Public outreach

The blog articles were written for the SMNS science blog (Schmid & Schubert 2021), as well as for the Nixenzauber blog (Mertz & Mört 2021), in order to disseminate knowledge of galls (Figure 35).

Figure 35: Insight into the gall article on the blog Nixenzauber (Mertz & Mört 2021) (Image credit: Mertz & Mört).

They are written in German and use simple words, examples, and photographs so that children and adults without biological knowledge can follow the post. Feedback on the blog and social media shows that many find the topic exciting and are happy to learn something about galls.

In addition, there is feedback that galls have been already noticed in nature, but most of the audience had never heard about galls before. The blog article got nine comments and 157 views in 5 days. The Instagram article received 172 likes and 30 comments in 5 days. Around 700 people saw the article, and it was shared several times. Over the last eight months, the story posts on this topic have also been well received and commented on several times. The author has already been sent several pictures with galls on leaves to show that they have been discovered in nature. Among them were common galls like *Neuroterus numismalis, Neuroterus albipes*, and *Mikiola fagi*.

The feedback shows that the blog article is easy to understand, gives a nice overview of the topic and that the audience is fascinated by galls.

4. Discussion

4.1 Importance of historical collections

Collections from the past are incredibly important. They show what kind of organisms were found at which times and in which places. This allows researchers to make conclusions about the occurrence and also about change over time. There may be clues as to what species were found at the locations over time that may no longer exist today. There is also the possibility of finding treasures in the historical collections, such as new species or discoveries for certain areas. Historical collections thus provide not only a window into the past and its biodiversity but also scientific breakthroughs. That is why it is important to go through the old collections regularly or to digitize them. A review of the taxonomic names is also important, especially for old collections. The nomenclature must be updated to a modern standard.

In the SMNS, there are many more galls from other parts of Germany and the world. For this project, only a small fraction was added to the database and digitized. Many other galls in the SMNS also need to be added to the SMNS gall collection and digitized. Using the new range of accession numbers and the techniques established by this study, continuing the digitization process should be easier in the future.

There are many more galls from around the world in the SMNS that have not yet been cataloged and entered into the DWB. In future projects, more galls from the museum can be added and digitized to the gall collection for future research.

4.1.1 Phenology

The galls in the SMNS collection were sampled throughout the year. However, the fact that galls were collected every month shows that it is possible to find galls at any time of the year. Most galls (351 out of 474, about 74 %) were collected in August, September, and October. In these months, there are particularly conspicuous galls. Also, the later in the year the galls are taken, the more "mature" the organisms are, and there is a good chance of rearing them from the galls. For example, many oak galls become visible in July and hatch in the fall. Many galls also overwinter in the soil and hatch in the spring (Bellmann et al. 2018). Thus, it makes sense to collect the galls in the fall before they fall off the leaves. These two reasons may explain why 74 % of the galls were collected in August, September, and October.

However, no organisms coming from the galls were found in the 395 objects from the collection. Thus, it is not possible to say whether the organisms were already hatched before the galls were collected, whether they are located elsewhere, or whether they were still in the galls. It is possible to determine the galls based on their appearance, but it is still important to know which organisms come from the galls. To better understand the ecosystem, the galls should be collected and stored together with their inhabitants, including parasites and inquilines.

In addition to the seasons when it is best to collect galls, the goal and time of each collector make a difference. Many galls in the collection are on leaves. For example, Antonio Wünsch collected galls for his project on the leaves of *Salix* from July to November. Trying to collect galls on leaves in winter would not have made sense.

4.1.2 Gall formers

Oak galls and especially cynipid galls are particularly conspicuous and are readily collected. Some cynipid species were extremely well-represented in the collection. *Cynips longiventrius,* for example, occurs on 22 specimens from the collection and *Macrodiplosis pustularis* 29 times. *Neuroterus quersusbaccarum* occurs on 40 specimens.

Galls of Hymenoptera dominate with 224 specimens in the collection, followed by Diptera with 91 specimens. Antonio Wünsch has dealt particularly intensively with the Cecidomyiidae fauna. His collection includes 34 dipteran specimens. Therefore, there are also many dipteran galls in the collection.

A large proportion of gall formers are insects (Bellmann et al. 2018). Out of 490 galls, 354 are insects. This corresponds to about 72 %. Thus, the main part of the gall formers in the SMNS gall collection are insects. This is not surprising, as we only examined galls in the entomology collection. It is possible that the botanical and fungal collections may also include galls and that the taxonomic diversity of these collections is differently biased.

A total of 94 different species from the collection could be identified. Sixteen of the species from the collection were not found in any of the known checklists and are newly listed for Baden-Württemberg. However, many galls have not yet been identified. In a

further project, all the galls that have been digitized so far could be reidentified. The specimen data is already in the DWB, so updating the identification field would be fairly simple.

4.1.3 Gall hosts

Many gall formers are host-specific. Therefore, it is very important to identify the hosts, include them, and collect the galls with a part of the host. Ideally, a large amount of host material should be collected to allow for expert identification in the future. For example, plant samples should include several leaves attached to the stem.

In general, many galls are specialized in *Quercus*. Galls on oaks are very often represented in the collection. With 198 out of 490, the most common host in the SMNS gall collection is the genus *Quercus*.

Salix is also very often represented in the SMNS gall collection (145 out of 492). This is mainly due to the collection of Wünsch. His thesis research focused on the galls of *Salix*, so he collected a lot of *Salix* galls. His collection includes 134 *Salix* specimens.

Besides *Quercus* and *Salix*, there are other hosts in the collection. Some of them are identified to family or genus but not to species (128), and 53 specimens are not identified. A re-determination is important to better understand the relationship between host and gall. In addition, there is a possibility that the gall's host is not yet known. The more information about the specimen is known and recorded in the DWB, the better it can be used for scientific research.

4.1.4 Distribution

The distribution map shows the collection locations of the 395 specimens. Many are located in the same place or nearby. Two major collecting areas can be seen. One is around Stuttgart, where the SMNS is located. The other is an area in the Allgäu west of Lake Constance.

Otherwise, only a few were collected elsewhere. The localities are strongly dependent upon the residential area of the collectors. The botanist Brielmaier collected a lot in and around his home in Wangen, so there are many collecting points in this area.

Unsurprisingly, another intensive collection point is around Stuttgart, where the SMNS is located. This is mainly due to Prof. Möhn, who worked in the SMNS, and Antonio Wünsch, who wrote his thesis there. Wünsch and Möhn collected many specimens from the collection.

One specimen point (accession number 349) in the collection is located outside of Baden-Württemberg. The unidentified gall was collected near Lindau in Bavaria. By mistake, this was added to the galls from Baden-Württemberg. Since DWB will include all galls from SMNS under this range in the future, it was not removed subsequently. For the gall checklist and phenological analysis, this specimen was ignored.

4.1.4.1 Unsampled parts of Baden-Württemberg

The SMNS houses many galls from all over the world. From Baden-Württemberg, only 394 are included in the DWB. There are a few more galls in the museum, but they are not considered part of the new SMNS gall collection. These galls belong to the von Roser collection and are also collected around Stuttgart. In addition, there are certainly other galls from Baden-Württemberg in the SMNS, but not in the gall cabinets. Besides the galls in the entomology collection, the botany and mycology collections may also include galls. It is even possible that there are galls in the paleobotany collection.

Based upon the distribution map, many places remain to be investigated. The Black Forest, with its wildness, has a high potential for many galls, but also the Rhine Valley with its heat-loving flora and fauna. These are fascinating places, and possibly rarer gall species are represented there.

To give a definite range of galls and of the individual species, much local mapping is needed. As Ross said in 1927: „Es müssen also zunächst lokale ‚Gallenfloren' entstehen, welche dann später als Grundlage für eine Übersicht der Gallbildungen eines größeren Gebietes dienen können. Erst dann wird es möglich sein, zuverlässige Angaben über die Verbreitung der Gallenerreger innerhalb unseres Gebietes zu geben" ("Thus, local 'gall floras' must first be created, which can later serve as the basis for an overview of the gall formations of a larger area. Only then will it be possible to give reliable information about the distribution of gall floras within our area") (Ross & Hedicke 1927).

Mapping many small localities is important to get an overall picture for a large state like Baden-Württemberg. In Baden-Württemberg, several galls are known to have been found, but the data has not been formally recorded and published.

In addition, the focus is usually on one group of galls. Other galls from the area are ignored and not listed. However, for a large and accurate overview, all types of galls are important. An inclusive approach is helpful for identification, as the taxonomic group of the gall former is not always immediately obvious.

Baden-Württemberg offers many exciting places for local gall mapping. A mapping project, similar to that for reptiles and amphibians in Baden-Württemberg (LUBW 2014), would help to catalog the gall-forming ecosystems of the state. Often photo documentation would be enough, which would allow participation from citizen scientists and amateur naturalists. This is an exciting project for the future to keep a better eye on the occurrence of galls in Baden-Württemberg.

4.1.5 Storage methods

There are six different types of storage in the collection. However, finding the perfect method of storage for galls is not that easy. None of the six storage types is the perfect one for galls. Each storage type has its advantages & disadvantages.

Envelopes: are suitable for compact storage of smaller galls, especially for galls on leaves. The envelopes in the collection are quite small, but larger envelopes can be used for larger galls.

Letter envelopes are not well sealed. The material could fall out or be damaged when folding the folded-paper envelopes. In addition, most envelopes are made of paper and are therefore not transparent. In the case of envelopes made of transparent plastic, the gall can be seen immediately. However, the specimen usually covers part of the label, so the envelope still has to be opened for all the information.

Herbarium sheets: The herbarium sheet is large, making storage difficult in a typical entomology collection. Nevertheless, it is compact. They are currently stacked in large cardboard boxes. At first sight, only the top herbarium sheet can be seen, so a quick overview is difficult. In addition, for herbarium sheets, the type of glue used is important. The specimens are glued on a paper sheet and should adhere well, even

many years later. Often galls are not flat, which makes storage and adhesion more difficult. Thicker galls cannot be stored on an herbarium sheet, as they may be dented or damaged.

“Notebooks”: The “notebooks” are similar to the herbarium sheet. The size of the herbarium sheets within a “notebook” is uniform. The varying thickness of the galls makes the “notebook” thick on one side. A “notebook” is flipped through, which ensures that the specimens are often placed upside down. This is not good for the specimens. The risk of parts breaking off and slipping out of the sides is high. As with herbarium sheets, glue is particularly important. Adhesive tape such as Scotch or Tesa is not suitable for attaching galls and hosts. Over time, the adhesive strength dissolves, and the adhesive tape turns brownish and becomes porous. Storage as a “notebook” should generally be avoided.

Clear plastic folders: This stored method is similar to the “notebook“, but the herbarium sheets are inside clear plastic folders and are better protected. Thicker galls and hosts are not suitable for this method. The pages will become thick, or the specimens will be compressed. Uniform storage is also not possible, and one does not have a good overview of all galls.

Cardboard boxes: In cardboard boxes, the galls can be well protected and, depending on the size of the box, all galls and their hosts can fit. The disadvantage is that a lot of space is needed if each gall gets a box. If the boxes do not have lids, there is good visibility. However, the galls are then not protected from above. In addition, it is challenging to store many boxes in different sizes.

Insect drawers: Pinned galls in insect drawers have the advantage of a very good overview. At first sight, the galls can be easily seen through the glass cover. This method integrates well with the existing insect collection infrastructure. However, the drawers are quite large, and several galls would be in one insect drawer. A clear demarcation using unit trays would be better for a good overview. Even if several galls can be stored in one drawer, a lot of room is needed for a large collection. In addition, the galls are well protected in the insect drawers, and galls of different sizes can find space. This method is advisable if there is enough room.

It is not so easy to find the perfect way to store galls. On herbarium sheets, the plants are often fragile and disintegrate. If there is little space available, it is advisable to

choose a uniformly folded envelope system. This system may be combined with small cardboard boxes for the thicker galls that do not fit in envelopes.

If space is available, insect drawers with glass lids, in which unit trays are placed, are advisable. Similar galls can then be found together in one insect drawer but in different unit trays for separation. This method also has the advantage of fitting in well with the existing entomology collection infrastructure. In addition to the gall with part of the host, the box inside the insect drawers should have all the organisms that hatched from the gall. Good labeling is also very important. The name of the gall former, the name of the host, and the names of all organisms that came out of the galls and their numbers must be noted, if possible, identified to species. The location of the gall, preferably with a GPS point, as well as a date and collector, should accompany the specimen.

4.1.6 Research benefits from a gall collection

Galls connect multiple levels of life. Through the various levels of parasitization and their inquilines, galls provide insight into the web of life. The gall collections from universities and museums, as well as from private collectors, thus indicate different organisms and their coexistence. The collections preserve a large network of living organisms and show the habitat and the fascinating structures of nature.

Old gall collections offer a view into the biodiversity of the past and provide an opportunity to detect changes. New and old gall collections help to better understand current biodiversity and its relationships. They also help to create checklists for different areas.

In addition, the storage options of the past show which storage methods are useful or less useful. Through years of storage, it becomes apparent whether a given method is suitable for a longer time. Thus, "old collections" offer the chance to design a future, optimal gall storage system. This information can be used to create a standard for how gall collections can look around the world in the future.

4.1.7 Limitations of the databasing and digitization project

The boundaries of the project refer to the federal state of Baden-Württemberg. Thus, a large part of the galls from the SMNS was disregarded because they originate from other parts of Germany or the world.

Furthermore, only the galls from the SMNS entomology collection were used, which were found in four large cabinets. The galls in the insect drawers and the von Roser collection were not removed from their current locations. Other departments in the SMNS have not yet been surveyed for gall specimens.

Despite the scope of the project, which was limited by time and labor, the present study provides a foundation for continued curation and digitization of gall specimens at the SMNS and other museums.

4.2 Gall checklist of Baden-Württemberg

This is the first checklist for gall-formers of Baden-Württemberg. For Baden-Württemberg, there are other checklists that are not as comprehensive. For example, the Cecidomyiidae checklist is focused on one insect family (Skuhrava et al. 2014). The gall checklist of Swabia (Huber 1975) covers all galls, but the area includes parts of Bavaria. There is also a great checklist of oak galls in Ludwigsburg (Pfützenreiter & Weidner 1958), but this one only focuses on *Quercus*.

There are similar gall checklists for other parts of Germany or other parts of the world, for example, the gall checklist of the National Park “Unteres Odental” (Deckert & Deckert 2015), the checklist from Knüllwald in Hesse (Flügel 2016), or the checklist of South-Tirol (Hellrigl 2012).

4.2.1 New records for Baden-Württemberg

One hundred and five species may be considered new records for Baden-Württemberg. All 105 species are already known from Germany. They have also probably been found and possibly noted in Baden-Württemberg for years. However, they have not been officially recorded for Baden-Württemberg due to insufficient observation and publications, or the author did not find the information.

4.2.2 Limitations of the checklist project

Due to time constraints and the Corona situation, it was not possible to make field trips with gall experts to different locations throughout Baden-Württemberg. Furthermore, the perfect collecting time is in August, September, and October, and therefore almost too late in the year for the current study. For this reason, only a few excursions around Stuttgart were possible. On the field trips with Ronja Reinisch, 21 galls were discovered and identified. Without gall experts, it is difficult to find inconspicuous galls such as root galls. Additional observations were provided by Roland and Margot Spohn (personal communication). Due to the few existing checklists of galls for Baden-Württemberg, it was also not easy to list all galls that occur in Baden-Württemberg. For a detailed checklist, more biodiversity projects on galls have to be run. In addition, the inquilines

and the parasites are also interesting, which are not considered in this project but can offer conclusions on gall occurrences.

4.2.3 Importance of species checklists

Species checklists and indexes are incredibly important. They show which species occur in a given area (continent, country, state). Collected local faunal data are important to be able to record the current gall population as well as its changes. Thus, they provide an important basis for distribution ranges, changes, and information on how common or rare certain species are. With the help of this information, environmental protection and nature conservation can be better coordinated and adapted. The data can be used to compile Red Lists, which provide information about endangered, lost, and extinct animal and plant species in a given area. Occurrence provides information on the degree of endangerment of individual species. Only with the help of checklists, which list all species of the group occurring in an area, can the important Red Lists be compiled (Rote-Liste-Zentrum 2021).

For this reason, it is particularly important to indicate where each species was seen or collected, ideally by using a GPS point. Alternatively, it is also possible to provide exact locality information, which can be easily traced even years later.

Red Lists of animals, plants, and fungi are compiled scientifically and show the endangerment of native species. Red Lists serve as an always-available expert opinion, as an argumentation aid for environmentally relevant planning, and as an early warning system for the development of biological diversity. They show the priority need for species protection to preserve the entirety of wild, native species, not only in individual protected areas but also in the largest possible sections of the landscape. In addition, the Red Lists' missing data draw attention to the importance and need for increased monitoring and research. Biodiversity projects, such as the occurrence of certain gall-formers or insect monitoring, are therefore incredibly important (Rote-Liste-Zentrum 2021).

Biodiversity projects that provide important information for species registers and Red Lists are thus essential for nature conservation. Therefore, the mission to compile the checklists is established in the State Nature Conservation Law of June 23, 2015 (§39 NatSchG) (LUBW 2021).

4.3 Public outreach

Galls have been ignored and forgotten for years, so, unfortunately, the average person does not know about them. The blog articles aim to change this. In addition, the spreading of gall information already shows an effect. On social media, the author regularly shares photos of galls along with information about them. The response is very positive. Several people have contacted the author on the subject and have been told enthusiastically that galls have been found in nature. Several photos have also been sent. Common galls, like *Mikiola fagi* on beech and various cynipid galls from *Quercus,* are found. There are also positive reactions to the blog articles. The audience liked the overview and the information about galls and are really fascinated by this topic.

This shows that people are interested in the topic and that it needs to be addressed more often. It would be very pleasing if galls appear in more nature picture books and children's science books in the future. The author will work on this in the future and perhaps design a children's science book on this topic herself. The knowledge about nature and the fascinating processes on our doorstep should in no case be forgotten.

4.4 Further research

There is already a lot of scientific knowledge of galls, and many species are quite well researched. However, most studies are rather general or limited to eye-catching species or species of economic importance. Each gall species is different and more research on poorly known species can help understand the different processes and communities. This knowledge can also contribute to ecological research on parasitic "dark taxa" species.

The occurrence of galls in different areas and their distribution is also of great interest. This knowledge is immensely important for species inventories and the compilation of Red Lists. With the help of distribution data and occurrences, an important contribution to nature conservation can be made.

In addition, it is still unknown how the distribution of galls has changed over the years. Have galls become more common or less common? Are certain galls particularly noticeable and common? Historical gall collections are incredibly important to make comparisons with each other and notice any changes. Future projects could examine the effects of climate change on galls and their micro-ecosystem. For such projects, digitization of galls from museums and universities is very important. Only in this way can sufficient information become visible and available. Eventually, new species can be determined or listed for new areas with the help of digitized data.

In the field of cecidology, there are still plenty of questions to be answered, discoveries to be made, and further research to be done. The results of such research are relevant to conservation biology, ecology, and education.

5. Conclusion

We hypothesized that the arthropod diversity of the gall collection at SMNS would reflect the arthropod gall diversity of Baden-Württemberg. The data did not support the hypothesis. Of the 371 gall-forming arthropod species of Baden-Württemberg, only 93 were represented in the collection. Additionally, the collection shows a strong bias toward cynipid oak gallers. In addition, many areas of Baden-Württemberg are still uncollected. For example, very little is known of the gall fauna of the Black Forest.

This collecting bias has advantages and disadvantages. A disadvantage, of course, is that many species are not represented in the collection at all. This makes it difficult to identify these species and also impedes historical research on these species. However, there are advantages to having large amounts of data on a single species. For example, such collections are useful for studying how species respond to climate change, pollution, or habitat destruction over time.

The present study demonstrates the potential of gall collections, like that at the SMNS, to contribute to diverse fields of study. Curation and digitization are relevant to museum studies, faunistics is relevant to zoology, and public outreach contributes to education. Integrating all of these factors is necessary to the conservation of important and fascinating natural systems like galls.

The response to the public outreach has been very positive. The article on galls has already been read and commented on several times. This shows that there is interest in the galls. The comments indicate that this natural phenomenon was previously unknown to most readers. Additionally, feedback suggests that some readers are now searching for galls in nature.

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7. References

7.1 Literature

Albert R. (2009): Globalisierungsgewinner unter den Schädlingen. Landwirtschaftliches Technologiezentrum Augustenberg.

Askew R.R. (1984): The biology of gall wasps. In Biology of gall insects. Edited by T.N. Ananthakrishnan. Oxford and IBN, New Delhi, India. pp. 223–271.

Bellmann H. (2012): Geheimnisvolle Pflanzengallen. Ein Bestimmungsbuch für Pflanzen und Insektenfreunde. Wiebelsheim, Quelle & Meyer.

Bellmann H., Spohn M., Spohn R. (2018): Faszinierende Pflanzengallen – Entdecken, Bestimmen, Verstehen. Quelle & Meyer, Wiebelsheim.

Benz G. (1998): Wechselseitige Beziehungen zwischen Insekten und Pflanzen als Beispiele von Koevolution. Neujahrsblatt von der Naturforschenden, Gesellschaft in Zürich.

Blessing K. (2014): Wildes Baden-Württemberg – dunkle Wälder, grüne Höhen. National Geographics Buchverlag Gmbh, Hamburg. ISBN: 978-3866904019.

Böhner K. (1933/35): Geschichte der Cicidologie, I. und II. Neumayer.

Bouras A. (2021): Deutscher Wetterdienst: https://www.dwd.de/DE/Home/home_node.html; Access: August 2021.

Brewin N. J (2010): Root Nodules (Legume–Rhizobium Symbiosis). John Wiley & Sons, Inc.

Brooks S. E., J. D. Shorthouse (1998): Developmental morphology of stem galls of *Diplolepis nodulosa* (Hymenoptera: Cynipidae) and those modified by the inquiline *Periclistus pirate* (Hymenoptera: Cynipidae) on *Rosa blanda* (Rosaceae). Can. J. Bot. 76: p.365–381.

Buhr H. (1964/1965): Bestimmungstabellen der Gallen (Zoo und Phytocecidien) an Pflanzen Mittel- und Nordeuropas, 2 Books. VEB Fischer, Jena.

Buhr H.J. (2007): Fotogalerie Pflanzengallen: www.pflanzengallen.de; Access: August–October 2021.

Capture One (2021): https://www.captureone.com/de; Access: March, October 2021

Carnegie Museum (2019): Digitizing Natural History - A new era for museum collections in the digital age: https://studio.carnegiemuseums.org/digitizing-natural-history-7362c224010; Access: October 2021.

Catalogue of life (2021): Catalogue of Life checklist: https://www.catalogueoflife.org/; Access: September–October 2021.

Csoka G. (1997): Gubacsok Plant Galls. Forest Research Institute; Agro in form, Budapest.

Czech K. (1858): Neue Eintheilung der Pflanzengalle. Gross, Barth & Co., Düsseldorf.

Deckert C. & J. (2015): Pflanzengallen im Unteren Odertal, Kommentierte Artenliste. Nationalpark-Jahrbuch Unteres Odertal 12, 143–158.

Degen B. (2020): Auftreten und Verbreitung des Quarantäneerregers *Candidatus Phytoplasma ulmi* in den Ulmen-Arten Deutschlands. Thünen Institut für Forstgenetik: https://www.thuenen.de/de/fg/projekte/abgeschlossene-projekte/phytoulmus/; Access: October 2021.

Ellis W.N. (2021): Leafminers and plant galls of Europe. Plant parasites of Europe: https://bladmineerders.nl/; Access: March–September 2021.

Flügel H.-J. (2016): Die Pflanzengallen (Zoocecidien) im Bereich des Lebendigen Bienenmuseums in Knüllwald (Nordhessen). The plant galls (Zoocecidia) from the area of the Living Bee Museum in Knuellwal. LEBBIMUK, Abhandl. Ber. Lebend. Bienenmuseum Knüllwald 13.

Forneck A., Mammerler R., Tello J., Breuer M., Müller J., Fahrentrapp J. (2019): First European leaf-feeding grape phylloxera (Daktulosphaira vitifoliae Fitch) survey in Swiss and German commercial vineyards. European Journal of Plant Pathology 154(4), p. 1029–1039.

Fröschle M., Krämer P. (2001): Jahresbericht 2001. Pflanzenschutzdienstes Baden-Württemberg.

Funke H.G., Köppler K. (2019): Integrierter Pflanzenschutz 2019. Erwerbsobstbau; Landwirtschaftliches Technologiezentrum Augustenberg.

Gaedike R., Heinicke, W. (1999): Verzeichnis der Schmetterlinge Deutschlands (Entomofauna Germanica 3), Entomologische Nachrichten und Berichte, Beiheft 5, p. 74.

Gagné R.J., Jaschhof M. (2014): A Catalog of the Cecidomyiidae (Diptera) of the World. 3rd Edition. Systematic Entomology Laboratory, Agricultural Research Service, Washington, p. 493.

Gauß R. (1976): Aberrante Gallen der Knoppern-Gallwespe (*Andricus quercuscalicis* BURGSD.) im Raum Stuttgart. Mitteilungen des Badischen Landesvereins für Naturkunde und Naturschutz e.V. Freiburg i. Br. NF 11, p. 359–362.

Global Biodiversity Information Facility (2021): Gbif checklist: https://www.gbif.org/; Access: March–September 2021.

Gullan P. J., Miller D. R., Cook L. G. (2005): Gall-inducing Scale Insects (Hemiptera: Sternorrhyncha: Coccoidea); In book: Biology, ecology, and evolution of gall-inducing arthropods. Vol. 1, p. 159–229.

Harmunth P., Krämer P., Buhr C. (1999): Jahresbericht 1999. Pflanzenschutzdienst Baden-Württemberg.

Hedrick B. P., Heberling J.M., Meineke E.K., Turner K. G., Grassa C.J., Park D.S., Kennedy J., Clarke J. A., Cook J. A., Blackburn D. C., Edwards S. V., Davis C. C. (2020): Digitization and the Future of Natural History Collections. BioScience Vo. 70 No. 3, p. 243–251.

Hellrigl K. (2010): Pflanzengallen und Gallenkunde. Plant Galls and Cecidology; forest observer vol. 5 p. 207–328.

Hellrigl K. (2012): Gallenkunde – Cecidologie in Südtirol: Gallwespen (Hym., Cyni-pidae), 3. Teil.– Forest Observer, 6: p. 311–399. Landesforstdienst, Abteilung Forstwirtschaft, Autonome Provinz Bozen Südtirol. Bozen.

Hieronymus G. (1890): Beiträge zur Kenntnis der europäischen Zoocecidien und der Verbreitung derselben. Ergänzungsheft zum 68. Jahresbericht der Schlesischen Gesellschaft für vaterländische Cultur: p. 49–272.

Huber J. A. (1975): Pflanzengallen Schwabens. Bericht der Naturforschenden Gesellschaft Augsburg 23: p. 137–204.

Köppler K., Funke H.G. (2015): Pflanzenproduktion 2015. Pflanzenschutz im Erwerbsobstbau. Landwirtschaftliches Technologiezentrum Augustenberg.

Körner H. (2006): Der Schönberg – Natur- und Kulturgeschichte eines Schwarzwald-Vorbergs. Badischen Landesvereins für Naturkunde und Naturschutz e.V. Lavori Verlag.

Kopelke J.-P. (2008): Lebensraum Pflanzengalle Biodiversität auf kleinstem Raum. Natur und Museum 138 (5/6): p. 134–136.

Korotyaev B. A., Konstantinov A. S., Lingafelter S. W., Mandelshtam M. Y., Voklovitsh M. G. (2005): Gall-inducing Coleoptera; In book: Biology, ecology, and evolution of gall-inducing arthropods. Vol. 1 p. 239–271.

Küster E. (1911): Die Gallen der Pflanzen. Ein Lehrbuch für Botaniker und Entomologen. Leipzig, Verlag v. S. Hirzel.

Lampe I., Burghause F., Krauthausen H.J. (2005): Introduction and distribution of the American Eastern Cherry Fruit Fly, *Rhagoletis cingulata,* in the Rhine Valley, Germany. Proceedings of

the BCPC Symposium on ‘Introduction and spread of invasive species’, Berlin, 200506-09/11, No. 81, p. 135–140.

Landesarchiv Baden-Württemberg (2021): Entdecken Sie Baden-Württemberg: https://www.leo-bw.de/web/guest/home; Access: September 2021.

Lepiforum e.V. (2021): Bestimmung von Schmetterlingen und ihren Präimaginalstadien: https://lepiforum.org/; Access: October 2021.

Liljeblad J., Ronquist F. (1998): A phylogenetic analysis ofhigher-level gall wasp relationships. Syst. Entomol. 23:229–252.

LUBW (2014): Landesanstalt für Umwelt Baden-Württemberg, LAK Amphibien und Reptilien (Mapping Project Reptilia and Amphibia): https://www.lubw.baden-wuerttemberg.de/natur-und-landschaft/landesweite-artenkartierung-lak; Access: September 2021.

LUBW (2021): Landesanstalt für Umwelt Baden-Württemberg, Rote Listen und Artenverzeichnisse (Checklists Baden-Württemberg): https://www.lubw.baden-wuerttemberg.de/natur-und-landschaft/rote-listen; Access: October 2021.

Malpighi M. (1687): Opera omnia. Partis Secundae Anatomiae Plantarum: De Gallis, p. 112–132, Fig.15-72. –London.

May H. (2014): Bizarre Wucherungen Natur vor der Haustür: Beobachtungstipp Pflanzengallen. Naturschutz heute, Heft 2: p. 44.

Melika G. (2006): Gall Wasps of Ukraine. Cynipidae Vol. 1 & Vol. 2: Supplem. 21: 644 pp. – Vestnik zoologii: Schmalhausen Institute of Zoologie N.A.S. of Ukraine.

Mertz A. (2021): Instagramseite MermaidKathi: https://www.instagram.com/mermaidkathi/; Access: March–October 2021.

Mertz A., Mört N. (2021): Nixenzauber Blog: https://nixenzauber.home.blog/; Access: October 2021.

Meyer H., Jaschhof M. (1999): Cecidomyiidae: Cecidomyiinae, Lestremiinae, Porricondylinae, p.18-32. In: Schumann H., Bährmann R., Stark A. (eds.) Entomofauna Germanica 2 - Checkliste der Dipteren Deutschlands. Studia dipterologica Supplement 2.

Miller W. E. (2005): Gall inducing Lepidoptera: In book: Biology, ecology, and evolution of gall-inducing arthropods. Vol. 2 p. 431–465.

Müller T. (2020): Die wunderbare Welt der Eichen. Gerstenberg Verlag.

Naturkundemuseum Berlin (2021): Spuren des Krieges bis heute sichtbar: https://www.museumfuernaturkunde.berlin/de/ueber-uns/bau/spuren-des-krieges-bis-heute-sichtbar, Access: October 2021.

Neger F. W. (1910): Ambrosiapilze III. Weitere Beobachtungen an Ambrosia gallen; Ber. Deut. Bot. Ges. 28, 455–482.

Öfele F.v., Böhner K. (1933); Geschichte der Cecidologie I., Mit einer Vorgeschichte zur Cecidologie der klassischen Schriftsteller von Felix von Öfele. Neumayer.

Oldfield G. N. (2005): Biology of Gall-inducing Acari. In book: Biology, ecology, and evolution of gall-inducing arthropods. Vol. 1 p. 35–57.

Pfützenreiter F., Weidner H. (1958): Die Eichengallen im Naturschutzgebiet Favoritepark in Ludwigsburg und ihre Bewohner. p. 88-130 In: Buchwald K, Rathfelder O, Zimmermann W (eds.) Naturschutz und Landschaftspflege in Baden-Württemberg. Veröffentlichen der Landesstelle für Naturschutz und Landschaftspflege Baden-Württemberg und der württembergischen Bezirkstellen in Stuttgart und Tübingen, Heft 26.

Pl@ntNet (2013): Application to identify plants: https://plantnet.org/en/; Access: June - October 2021.

Raman A., Schaefer C. W., Withers T. M. (2005): Galls and Gall-inducing Arthropods: An Overview of their Biology, Ecology, and Evolution. In book: Biology, Ecology, and Evolution of Gall inducing Arthropods Volume 1, p. 1–33. Enfield (NH), USA, Science Publishers, Inc.

Redfern M., Shirley P., Bloxham M. (2002): British Plant Galls. Identification of Galls on Plants and Fungi. AIDGAP, FSC Publications, Field Studies 10, (2002): p. 207–531.

Redfern M., Shirley P. (2011): British Plant Galls, 2. Edition. – 432 S.; Shrewsbury (Preston Montfora).

Rennwald K., Grabow K., Doczkal D. (2015): Erste Funde der Ringelblumen-Bohrfliege *Tephritis praecox* (Loew, 1844) in Deutschland (Diptera: Tephritidae); Mitteilungen des Entomologischen Vereins Stuttgart 50, p. 275–277.

Ring C. (2018): Hier wurde Wissen aus 200 Jahren an einem Tag vernichtet: https://www.welt.de/wissenschaft/article181410586/Rio-de-Janeiro-Feuer-brennt-Nationalmuseum-nieder.html; Access: October 2021.

Ross H. (1911): Die Pflanzengallen (Cecidien) Mittel- und Nordeuropas ihre Erreger und Biologie und Bestimmungstabellen. Jena: i-viii: 350 S. + Tafeln i-x.

Ross H., Hedicke H. (1927): Die Pflanzengallen (Cecidien) Mittel- und Nordeuropas, ihre Erreger und Biologie und Bestimmungstabellen. Jena, 2. Aufl.

Ross H. (1932): Praktikum der Gallenkunde (Cecidiologie). Berlin.

Rote-Liste-Zentrum (2021): https://www.rote-liste-zentrum.de/index.html; Access: October 2021

Sanver D., Hawkins B. A. (2000): Galls as habitats: the inquiline communities of insect galls. Basic Appl. Ecol. P: 1, 3–11. Urban & Fischer Verlag.

Schadewaldr G. (2009): Zur Verbreitung von *Andricus coriarius* (Hartig, 1843) insbesondere in Deutschland (Hymenoptera, Cynipidae). Entomologische Nachrichten und Berichte, 53, 2009/3-4, p. 181–187.

Schadewaldt G. (2017): Gallen von Gallwespen (Hymenoptera: Cynipidae) an Eiche in einer städtischen Grünanlage („Unter den Eichen“ – Wiesbaden, Land Hessen, BRD). Jahrbuch-Nassauischen-Verein-Naturkunde 138 p.0037–0068.

Schauer T., Caspari C. (1990): Der farbige BLV Pflanzenführer: nach Blütenfarben erkennen. 2. Überarbeitete Auflage, BLV Verlagsgesellschaft mbH, München.

Schlechtendal D.H.R. (1891): Die Gallenbildungen (Zoocecidien) der Deutschen Gefässpflanzen. Jahresb. d. Ver. f. Naturk. zu Zwickau 1891: p.1–122.

Schmid U., Hauser M., Doczkal D. (1998): Schwebfliegen-Typen (Díptera, Syrphidae) im Staatlichen Museum für Naturkunde Stuttgart. Volucella - Die Schwebfliegen-Zeitschrift Band 3, p. 75–84.

Schmid U., Schubert A. (2021): SMNS Science Blog: https://smnstuttgart.com/; Access: October 2021.

Schneller H., Rißler D., Zgraja G., Zunker M., Zimmermann O., Kost W., Lasch E., Schrameyer E. (2016): Erster Nachweis von ‚Aster-Yellows-Disease‘ an Möhren (Phytoplasmen bedingte Möhrenröte) und in der Kleinzikade *Macrosteles sexnotatus* (Fallén 1806) in Deutschland – Monitoring und Diagnose. Journal für Kulturpflanzen, 68 (10). p. 281–294.

Schmutterer H. (2003): Zur Schildlausfauna von Baden-Württemberg und benachbarten Gebieten (Coccina); Entomologische Nachrichten und Berichte, 47,2003/1; p. 13–17.

Schüz E., Harde K.W. (1963): Erwin Lindner 75 Jahre und die Entwicklung der Entomologie am Staatlichen Museum für Naturkunde in Stuttgart. Stuttgarter Beiträge zur Naturkunde aus dem Staatlichen Museum für Naturkunde in Stuttgart Nr. 100.

Shorthouse J., Rohfritsch O. (1992): Biology of Insect-Induced Galls – New York Oxford, Oxford university press.

Skuhravá M., Skuhravÿ V., Meyer H. (2014): Gall midges (Díptera: Cecidomyiidae: Cecidomyiinae) of Germany - Faunistics, ecology and zoogeography. Faunistisch-Ökologische Arbeitsgemeinschaft e.V, Kiel. - ISSN 0430-1285.

Spooner B.M. (2021): British Plant Gall Society: https://www.britishplantgallsociety.org/index.html; Access: August 2021.

State of Baden-Württemberg (2019): Initiative Integrative Taxonomie: https://mwk.baden-wuerttemberg.de/de/service/presse-und-oeffentlichkeitsarbeit/pressemitteilung/pid/initiative-integrative-taxonomie/; Access: August 2021.

State of Baden-Württemberg (2021): Official Baden-Württemberg Website: https://www.baden-wuerttemberg.de/de/unser-land/land-und-leute/geografie/; Access: August 2021.

Südwestrundfunk, Westdeutscher Rundfunk (2021): Planet Schule: https://www.planet-schule.de/wissenspool/geomorphologie/inhalt/hintergrund.html; Access: August 2021.

Taeger A., Liston A.D., Prous M., Groll E.K., Gehroldt T., and Blank S.M. (2018): ECatSym – Electronic World Catalog of Symphyta (Insect, Hymenoptera). Program version 5.0 (19 Dec 2018), data version 40 (23 Sep 2018). Senkenberg Deutsches Entomologisches Institut (SDEI), Münscheberg. https://sdei.de/ecatsym/ Access: 11 Oct 2021.

Team Tinten Center (2018): Wie wird Tinte hergestellt? Zur Produktion und Geschichte einer wertvollen Flüssigkeit: https://www.tintencenter.com/blog/wie-wird-tinte-hergestellt/ Access: October 2021.

Thines M. (2021). German Mycological Society: https://www.pilze-deutschland.de/; Access: October 2021.

Triebel D., Hagedorn G., Rambold G. (1999): Diversity Workbench – A virtual research environment for building and accessing biodiversity and environmental data. – http://www.diversityworkbench.net.

Walker F. (1848): List of the Specimens of Dipterous Insects in the Collection of the British mueseum Part 1. List of Diptera: Cecydomyia, Meigen: P. 29–31 London.

von Norsinski S. (2020): *Contarinia pseudotsugae* (Douglasiengallmücke). Kühn-Institut: https://pflanzengesundheit.julius-kuehn.de/contarinia-pseudotsugae.html; Access: September 2021.

Wehrmaker A. (1994): *Neuroterus saliens* (KOLLAR) und *Andricus grossulariae* GIRAUD: Zwei für das Naturschutzgebiet Favoritepark Ludwigsburg neue Zerreichen-Gallwespen (Hymenoptera: Cynipidae). Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg. Band 68/69.

Westermann digital GmbH (2021): Baden-Württemberg - Physische Übersicht; Diercke Westermann Gruppe: https://diercke.westermann.de/content/baden-w%C3%BCrttemberg-physische-%C3%BCbersicht-978-3-14-100852-4-11-3-1; Access: August 2021.

Westrich P. (2008): Zur Überflutungstoleranz von Hymenopteren in Gallen von *Lipara lucens* (Diptera: Chloropidae). – Eucera 1: 1–16.

Westwood B. (2021): DiscoverWildlife, How to identify plant galls: https://www.discoverwildlife.com/how-to/identify-wildlife/how-to-identify-plant-galls/; Access: August 2021.

Zieher M. (2021): Geoportal. Landesmedienzentrum BW: https://geo.lmz-bw.de/klima-bw/#/home; Access: August 2021.

Zimmermann O., Lehneis T., Wuthenau M. (2013): Die Japanische Esskastaniengallwespe (*Dryocosmus kuriphilus*) in Baden-Württemberg. Landwirtschaftliches Technologiezentrum Augustenberg.

7.2 Figure references

Cover: *Biorhiza palida*.: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000148.

Figure 1: *Pediapsis aceri*: Own figure, Stuttgart 2021.

Figure 2: Inside a gall, there is life: Own figure, Ehningen 2021.

Figure 3*: Neuroterus numismalis*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000099.

Figure 4: *Trigonaspis megaptera*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000114.

Figure 5: Leaf roll made by *Apoderus coryli*. It is not a true gall: Own figure, Stuttgart 2021.

Figure 6: *Torymus bedeguaris*: Own figure, 2021.

Figure 7: *Macrodiplosis pustularis*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000094.

Figure 8: *Neuroterus quercsbaccarum*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000138.

Figure 9: *Cynips divisa*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000098.

Figure 10: *Biorhiza palida*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000148.

Figure 11: *Cynips longiventris*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000350.

Figure 12: *Neuroterus numismalis*: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000099.

Figure 13: Witch's broom on birch.: https://commons.wikimedia.org/wiki/File:Hexenbesen_an_einer_Birke.JPG; Urheber: 4028mdk09, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons , cut. Access: 10.0.2021.

Figure 14: Robin's pincushion on wild roses.: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_0000385.

Figure 15: Map of Germany.: https://commons.wikimedia.org/wiki/File:Locator_map_Baden-W%C3%BCrttemberg_in_Germany.svg,https://upload.wikimedia.org/wikipedia/commons/4/44/Locator_map_Baden-W%C3%BCrttemberg_in_Germany.svg; Urheber: TUBS, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons. Access: 10.9.2021.

Figure 16: Mapping function in the DWB.: Triebel et al. (1999), Screenshot by Ann-Kathrin Mertz, Access: October 2021.

Figure 17: Screenshot of specimen SMNS_Ent_Gall_000142 in the Diversity Workbench.: (Triebel et al. 1999), Screenshot by Ann-Kathrin Mertz, Access: August 2021.

Figure 18: Digitization layout.: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_0000084. Edited with photoshop by Ann-Kathrin Mertz.

Figure 19: *Kiefferia pericarpiicola*: Own figure, Ehningen 2021.

Figure 20: SMNS Science Blog: SMNS, Schmid & Schubert (2021), Screenshot by Ann-Kathrin Mertz, Access: October 2021.

Figure 21: Nixenzauber Blog.: Mertz & Mört (2021), Screenshot by Ann-Kathrin Mertz, Access: October 2021.

Figure 22: Phenology of gall samples.: Own diagram made by Excel.

Figure 23: Gall formers in the SMNS from Baden-Württemberg: Own diagram made by Excel.

Figure 24: Number of gall specimens by host order.: Own diagram made by Excel.

Figure 25: Distribution map: Own figure made by DWB.

Figure 26: Stuttgart area distribution map.: Own figure made by DWB.

Figure 27: Digitazation. First image: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000099.

Figure 28: Digitazation. Second image: Christiane Dalitz & Ann-Kathrin Mertz. SMNS gall collection: SMNS_Ent_Gall_000099.

Figure 29: Envelopes: Own figure, 2021.

Figure 30: Herbarium sheet by T. Breunig: Own figure, 2021.

Figure 31: “Notebook” with galls by Antonio Wünsch.: Own figure, 2021.

Figure 32: Clear plastic folders filed in a ring binder.: Own figure, 2021.

Figure 33: Cardboard box: Own figure, 2021.

Figure 34: Insect drawer: SMNS J. Holstein, “Gallen 003”.

Figure 35: Insight into the gall article on the blog Nixenzauber: Mertz & Mört (2021). Screenshot by Ann-Kathrin Mertz, Access: October 2021.

8. Appendix

Table 10 First gall checklist of Baden-Württemberg. The symbol * marks the new records for Baden-Württemberg.

kingdom	order	family	species	Author	host
Animalia	Coleoptera	Cerambycidae	*Saperda populnea*	Linnaeus 1758	Salicaceae, oligophagous
Animalia	Coleoptera	Curculionidae	*Bostrichus kaltenbachi*	Bach 1849	Lamiaceae, oligophagous
Animalia	Coleoptera	Curculionidae	*Ceutorhynchus assimilis*	Paykull 1800	Brassicaceae, oligophagous
Animalia	Coleoptera	Curculionidae	*Gymnetron beccabungae*	L.1761	
Animalia	Coleoptera	Curculionidae	*Gymnetron villosulum*	Gyllenhal 1838	Plantaginaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Miarus campanulae*	Linnaeus 1767	Campanulaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Rhinusa anthirrhini (=Gymnetron a.)*	Paykull 1800	Plantaginaceae, oligophagpus
Animalia	Coleoptera	Curculionidae	*Rhinusa linariae*	Panzer 1792	Plantaginaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Smicronyx coecus*	Reich 1797	Convolvulaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Smicronyx jungermanniae*	Reich 1797	Convolvulaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Smicronyx nebulosus*	Tournier 1874	Convolvulaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Smicronyx reichii*	Gyllenhal 1835	Gentianaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Smicronyx smreczynskii*	Solari 1952	Convolvulaceae, monophagous
Animalia	Coleoptera	Curculionidae	*Tychius crassirostris*	Kirsch 1871	Fabaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Acericecis campestre*	Harris 2004	Sapindaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Acericecis vitrine*	Kieffer 1909	Sapindaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Ametrodiplosis auripes*	Low 1888	Rubiaceae, (narrowly?) monophagous
*Animalia	Diptera	Cecidomyiidae	*Ametrodiplosis rudimentalis*	Kieffer 1901	Asteraceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Arnoldiola quercus*	Binnie 1877	Fagaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Asphondylia fusca*	Meigen 1830	
Animalia	Diptera	Cecidomyiidae	*Asphondylia sarothamni*	Loew 1850	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Asphondylia scrophulariae*	Schiner 1856	Scrophulariaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Asphondylia verbasci*	Vallot 1827	Scrophulariaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Bayeriola salicariae*	Kieffer 1888	Lythraceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Buhromyiella giganteosaetosa*	Holz 1970	
Animalia	Diptera	Cecidomyiidae	*Camptodiplosis bolete*	Kieffer 1901	
*Animalia	Diptera	Cecidomyiidae	*Cecidomyia aurantiaca*	Macquart 1826	
*Animalia	Diptera	Cecidomyiidae	*Cecidomyia carnea*	Meigen 1818	

*Animalia	Diptera	Cecidomyiidae	*Cecidomyia griseicollis*	Meigen 1818	
*Animalia	Diptera	Cecidomyiidae	*Cecidomyia lateralis*	Meigen 1818	
*Animalia	Diptera	Cecidomyiidae	*Cecidomyia lutea*	Meigen 1804	
*Animalia	Diptera	Cecidomyiidae	*Cecidomyia palustris*	Linnaeus 1758	
Animalia	Diptera	Cecidomyiidae	*Contarinia aconitifloris*	Stelter 1962	Ranunculaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia aequalis*	Kieffer 1898	Asteraceae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia ballotae*	Kieffer 1898	Lamiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia coryli*	Kaltenbach 1859	Betulaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia jacobaeae*	Loew 1850	Asteraceae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia lilii*	Kieffer 1909	Liliaceaea, (narrowly?) monophagous
*Animalia	Diptera	Cecidomyiidae	*Contarina lonicerearum*	Löw 1877	Adoxaceae, Caprifoliaceae, narrowly polyphagous
Animalia	Diptera	Cecidomyiidae	*Contarinia loti*	De Geer 1776	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia medicaginis*	Kieffer 1895	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia melanocera*	Kieffer 1904	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia merceri*	Barnes 1930	Poaceae, (narrowly?) monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia nasturtii*	Kieffer 1888	Brassicaceae, broadly oligophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia nicolayi*	Rübsaamen 1895	Apiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia pastinaceae*	Skuhravá 1986	
Animalia	Diptera	Cecidomyiidae	*Contarinia picridis*	Kieffer 1913	Asteraceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia pseudotsugae*	Condrashoff 1961	Pinaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia pyrivora*	Riley 1886	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia quercina*	Rübsaamen 1890	Fagcaeae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia quinquenotata*	Löw 1888	Xanthorrhoeaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia sambuci*	Kaltenbach 1874	Adoxaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia scrophulariae*	Kieffer 1896	Scrophulariaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia steini*	Karsch 1881	Caryophyllaceae, oligophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia tiliarum*	Kieffer 1890	Malvaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia tragopogonis*	Kieffer 1909	Asteraceae,monophagous
Animalia	Diptera	Cecidomyiidae	*Contarinia tritici*	Kirby 1798	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Craneiobia corni*	Giraud 1863	Cornaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Cystiphora schmidti*	Rübsaamen 1914	Asteraceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Dasineura acrophila*	Winnertz 1853	Oleaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura alopecuri*	Reuter 1895	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura angelicae*	Rübsaamen 1916	Apiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura auritae*	Rübsaamen 1916	Salicaceae, narrowly monophagous

*Animalia	Diptera	Cecidomyiidae	*Dasineura bayeri*	Rübsaamen 1914	Brassicaceae, oligophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura bistortae*	Kieffer 1909	Polygonaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura cardaminis*	Winnertz 1853	Brassicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura crataegi*	Winnertz 1853	Rosaceae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura dryophila*	Rübsaamen 1917	Fagaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura engstfeldi*	Rübsaamen 1889	Rosaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Dasineura epilobii*	Löw 1889	Onagraceae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura excavans*	Kieffer 1909	Caprifoliaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Dasineura gleditchiae*	Osten Sacken 1866	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura hyperici*	Bremi 1847	Hypericaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura irregularis*	Bremi 1847	Sapindaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura loewii*	Mik 1882	Euphorbiaceae
Animalia	Diptera	Cecidomyiidae	*Dasineura mali*	Kieffer 1904	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura medicaginis*	Bremi 1847	Fabaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Dasineura napi*	Loew 1850	Brassicaceae, oligophagous
*Animalia	Diptera	Cecidomyiidae	*Dasineura odoratae*	Stelter 1982	Violaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura plicatrix*	Loew 1850	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura populeti*	Rübsaamen 1889	Salicaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura pteridis*	Müller 1871	Dennstaedtiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura pustulans*	Rübsaamen 1889	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura ranunculi*	Bremi 1847	Ranunculaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura rosae*	Bremi 1847	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura rubella*	Kieffer 1896	Sapindaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura sanguisorbae*	Rübsaamen 1890	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura sisymbrii*	Schrank 1803	Brassicaceae, oligophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura strumosa*	Bremi 1847	Lamiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura teucrii*	Tavares 1903	Lamiaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Dasineura tiliae*	Schrank 1803	Malvaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura tortilis*	Bremi 1847	Betulaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura tortrix*	Löw 1877	Rosaceae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura trifolii*	Löw 1874	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura tubicoloides*	Gagné 2004	Fabaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura tympani*	Kieffer 1909	Sapindaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura ulmaria*	Bremi 1847	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura urticae*	Perris 1840	Urticaceae, monophagous

Animalia	Diptera	Cecidomyiidae	*Dasineura viciae*	Kieffer 1888	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Dasineura violahirtae*	Stelter 1982	Violaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Didymomyia tiliacea*	Bremi 1847	Malvaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Drisina glutinosa*	Giard 1893	Sapindaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Geocrypta campanulae*	Müller 1871	Camapnulaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Geocrypta galii*	Loew 1850	Rubiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Giraudiella inclusa*	Frauenfeld 1862	Poaceae, monphaag
Animalia	Diptera	Cecidomyiidae	*Haplodiplosis marginata*	Roser 1840	Poaceae, oligophagous
*Animalia	Diptera	Cecidomyiidae	*Harmandiola cavernosa*	Rübsaamen 1899	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Harmandiola globuli*	Rübsaamen 1889	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Harmandiola tremulae*	Winnertz 1853	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Hartigiola annulipes*	Hartig 1839	Fagaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Iteomyia capreae*	Winnertz 1853	Salicaceae,monophagous
*Animalia	Diptera	Cecidomyiidae	*Iteomyia major*	Kieffer 1898	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella bryoniae*	Bouché 1847	Cucurbitaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella genistamtorquens*	Kieffer 1888	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella genisticola*	Löw 1877	Fabaceae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella inflatae*	Rübsaamen 1914	
Animalia	Diptera	Cecidomyiidae	*Jaapiella medicaginis*	Rübsaamen 1912	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella parvula*	Liebel 1889	Cucurbitaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella veronicae*	Vallot 1827	Plantaginaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Jaapiella volvens*	Rübsaamen 1917	Fabaceae,narrowly monophagous
*Animalia	Diptera	Cecidomyiidae	*Janetia panteli (Kiefferia p.)*	Kieffer 1909	Fagaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Kiefferia pericarpiicola*	Bremi 1847	Apiaceae, broadly oligophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera arundinis*	Schiner 1854	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera calamagrostidis*	Rübsaamen 1893	Poaceae, oligophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera carophila*	Löw 1874	Apiaceae, broadly oligophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera eryngii*	Vallot 1829	Apiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera flexuosa*	Winnertz 1853	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera hungarica*	Möhn 1968	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Lasioptera rubi*	Schrank 1803	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Lestodiplosis xylodiplosuga*	Skuhravá 2001	
*Animalia	Diptera	Cecidomyiidae	*Lestremia cinerea*	Macquart 1826	
Animalia	Diptera	Cecidomyiidae	*Loewiola centaureae*	Löw 1875	Asteraceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Macrodiplosis pustularis*	Bremi 1847	Fagaceae, monophagous

Animalia	Diptera	Cecidomyiidae	*Macrodiplosis roboris*	Hardy 1854	Fagaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Macrolabis brunellae*	Tavares 1907	Lamiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Macrolabis heraclei*	Kaltenbach 1862	Apiaceae, oligophagous
Animalia	Diptera	Cecidomyiidae	*Macrolabis lamii*	Rübsaamen 1916	Lamiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Macrolabis mali*	Anfora 2006	Rosaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Mayetiola alopecuri*	Ertel 1975	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Mayetiola destructor*	Say 1817	Poaceae, oligophagous
Animalia	Diptera	Cecidomyiidae	*Mayetiola graminis*	Fourcroy 1785	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Mayetiola hellwigi*	Rübsaamen 1912	Poaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Mikiola fagi*	Hartig 1839	Fagaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Monodiplosis liebeli*	Kieffer 1889	Fagaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis coniophaga*	Winnertz 1853	*Cirsium arvense*; Euphorbia; Rosa.
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis erysiphes*	Rübsaamen 1889	herbaceous plants
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis heterosaetosa*	Holz 1970	
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis isosaetosa*	Holz 1970	
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis melampsorae*	Rübsaamen 1889	Salicaceae – etc.?
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis oidii*	Hardy 1854	
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis pucciniae*	Rübsaamen 1889	*Leontodon autumnalis*; *Triticum vulgare*
Animalia	Diptera	Cecidomyiidae	*Mycodiplosis sphaerothecae*	Rübsaamen 1889	herbaceous plants
Animalia	Diptera	Cecidomyiidae	*Neomikiella lychnidis*	Vallot 1827	Caryophyllaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Obolodiplosis robiniae*	Haldeman 1847	Fabaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Ozirhincus anthemidis*	Rübsaamen 1916	Asteraceae, Anthemideae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Ozirhincus longicollis*	Rondani 1840	Asteraceae; Anthemideae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Ozirhincus millefolii*	Wachtl 1884	Asteraceae; Anthemideae, narrowly oligophagous
Animalia	Diptera	Cecidomyiidae	*Paradiplosis abietispectinatae*	Tubeuf 1930	Pinaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Parallelodiplosis galliperda*	Löw 1889	Fagaceae, monophagous
*Anamalia	Diptera	Cecidomyiidae	*Placochela nigripes*	Low 1877	Adoxaceae; Caprifoliaceae; Oleaceae
Animalia	Diptera	Cecidomyiidae	*Planetella product*	Meigen 1830	
Animalia	Diptera	Cecidomyiidae	*Planetella tuberifica*	Rübsaamen 1899	Cyperaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Rabdophaga albipennis*	Loew 1850	Salicaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga clavifex*	Kieffer 1891	Salicaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Rabdophaga degeerii*	Bremi 1847	Salicaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga dubiosa*	Kieffer 1891	Salicaceae, monophagous

*Animalia	Diptera	Cecidomyiidae	*Rabdophaga heterobia*	Loew 1850	Salicaceae, strictly monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga iteobia*	Kieffer 1890	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga marginemtorquens*	Bremi 1847	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga nervorum*	Kieffer 1895	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga pulvini*	Kieffer 1896	Salicaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga rosaria*	Loew 1850	Salicaceae,monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga saliciperda*	Dufour 1841	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rabdophaga salicis*	Schrank 1803	Salicaceae, monophagous
*Animalia	Diptera	Cecidomyiidae	*Rabdophaga terminalis*	Loew 1850	Salicaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rhopalomyia artemisiae*	Bouché 1834	Asteraceae, narrowly monophagous
*Animalia	Diptera	Cecidomyiidae	*Rhopalomyia millefolii*	Loew 1850	Asteraceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rhopalomyia ptarmicae*	Vallot 1850	Asteraceae,monophagous
Animalia	Diptera	Cecidomyiidae	*Rhopalomyia tanaceticola*	Karsch 1879	Asteraceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Rondaniola bursaria*	Bremi 1847	Lamiaceae, monophagous
Animalia	Diptera	Cecidomyiidae	*Sackenomyia reaumurii*	Bremi 1847	Adoxaceae, narrowly monophagous
Animalia	Diptera	Cecidomyiidae	*Schizomyia galiorum*	Kieffer 1889	Rubiaceae, oligophagous
*Animalia	Diptera	Cecidomyiidae	*Semudobia betulae*	Winnertz 1853	Betulaceae, monophagous
*Anamalia	Diptera	Cecidomyiidae	*Semudobia skuhravae*	Roskam 1977	Betulaceae, monophagous
Anamalia	Diptera	Cecidomyiidae	*Sitodiplosis mosellana*	Gehin 1857	Poaceae, oligofaag
Anamalia	Diptera	Cecidomyiidae	*Spurgia euphorbiae*	Vallot 1827	Euphorbiaceae, monophagous
Anamalia	Diptera	Cecidomyiidae	*Stenodiplosis geniculate*	Reuter 1895	Poaceae, monophagous
Anamalia	Diptera	Cecidomyiidae	*Taxomyia taxi*	Inchbald 1861	Taxaceae, monophagous
Anamalia	Diptera	Cecidomyiidae	*Tricholaba similis*	Rübsaamen 1917	Fabaceae, monophagous
Anamalia	Diptera	Cecidomyiidae	*Wachtliella caricis*	Loew 1850	Cyperaceae, broadly monophagous
Anamalia	Diptera	Cecidomyiidae	*Wachtliella persicariae*	Linnaeus 1767	Polygonaceae, oligophagous
Anamalia	Diptera	Cecidomyiidae	*Wachtliella stachydis*	Bremi 1847	Lamiaceae, monophagous
Anamalia	Diptera	Cecidomyiidae	*Zygiobia carpini*	Loew 1874	Betulaceae, oligophagous
Anamalia	Diptera	Chloropidae	*Lipara lucens*	Meigen 1830	Poaceae, monophagous
Anamalia	Diptera	Tephritidae	*Oxyna flavipennis*	Loew 1844	Asteraceae, oligophagous
Animalia	Diptera	Tephritidae	*Oxyna parietina*	Linnaeus 1758	Asteraceae, monophagous
Animalia	Diptera	Tephritidae	*Rhagoletis cingulata*	Loew 1862	Rosaceae, monophagous
Animalia	Diptera	Tephritidae	*Sphenella marginata*	Fallen 1814	Asteraceae, narrowly oligophagous
Animalia	Diptera	Tephritidae	*Tephritis praecox*	Löw 1844	Asteraceae, oligophagous
Animalia	Diptera	Tephritidae	*Urophora cardui*	Linnaeus 1758	Asteraceae, narrowly monophagous
*Animalia	Hemiptera	Adelgidae	*Adelges abietis/Sacchiphantes a.*	Linnaeus 1758	Pinaceae, monophagous

*Animalia	Hemiptera	Adelgidae	*Adelges viridis/Sacchiphantes v.*	Ratzeburg 1843	Pinaceae, monophagous
*Animalia	Hemiptera	Adelgidae	*Rhopalomyzus poae*	Gillette 1908	Caprifoliaceae, narrowly oligophagous; Poaceae, oligophagous
Animalia	Hemiptera	Aphalaridae	*Aphalara polygoni*	Foerster 1848	Polygonaceae, narrowly monophagous
Animalia	Hemiptera	Aphididae	*Adelges laricis*	Vallot 1836	Pinaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Aphidinius constrictus*	Heie 2006	
Animalia	Hemiptera	Aphididae	*Aphis podagrariae*	Schrank 1801	Apiaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Aphis symphyti*	Schrank 1801	Boraginaceae, monophagous
Animalia	Hemiptera	Aphididae	*Brachycaudus helichrysi*	Kaltenbach 1843	Asteraceae; Boraginaceae, polyphagous
*Animalia	Hemiptera	Aphididae	*Cryptomyzus korschelti*	Börner 1938	Grossulariaceae, narrowly monophagous; Lamiaceae, oligophagous
Animalia	Hemiptera	Aphididae	*Daktulosphaira vitifoliae (=Viteus v.)*	Fitch 1855	Vitaceae, oligophagous
*Animalia	Hemiptera	Aphididae	*Dreyfusia nordmannianae (= Adelges n.)*	Eckstein 1890	Pinaceae, narrowly monophagous
Animalia	Hemiptera	Aphididae	*Dysaphis plantaginea*	Passerini 1860	Rosaceae, narrowly oligophagous; Plantaginaceae, monophagous
Animalia	Hemiptera	Aphididae	*Dysaphis pyri*	Boyer de Fonscolombe 1841	Rosaceae, narrowly oligophagous; Rubiaceae, oligophagous
*Animalia	Hemiptera	Aphididae	*Eriosoma anncharlotteae*	Danielsson 1979	Ulmaceae, narrowly monophagous; Grossulariaceae, monophagous
Animalia	Hemiptera	Aphididae	*Eriosoma lanigerum*	Hausemann 1802	Ulmaceae, monophagous; Rosaceae, oligophagous
*Animalia	Hemiptera	Aphididae	*Eriosoma lanuginosum*	Hartig 1839	Ulmaceae, monophagous
Animalia	Hemiptera	Aphididae	*Eriosoma rileyi*	C.Thomas 1877	Pinaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Hayhurstia atriplicis*	Linnaeus 1761	Amaranthaceae, oligophagous
*Animalia	Hemiptera	Aphididae	*Macrosiphum funestum*	Macchiati 1885	Rosaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Myzus ligustri*	Mosley 1841	Oleaceae, monophagous
Animalia	Hemiptera	Aphididae	*Nasonovia compositellae nigra*	Hille Ris Lambers 1931	Asteraceae, narrowly oligophagous
Animalia	Hemiptera	Aphididae	*Pemphigus bursarius L*	Linnaeus 1758	Asteraceae, oligophagous
*Animalia	Hemiptera	Aphididae	*Pemphigus gairi*	Stroyan 1964	Salicaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Pemphigus phenax*	Börner & Blunck 1916	Salicaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Pemphigus populinigrae*	Schrank 1801	Salicaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Pemphigus protospirae*	Lichtenstein 1885	Apiaceae, oligophagous
Animalia	Hemiptera	Aphididae	*Pemphigus spyrothecae*	Passerini 1860	Salicaceae, monophagous
*Animalia	Hemiptera	Aphididae	*Prociphilus xylostei*	DeGeer 1773	Caprifoliaceae, narrowly monophagous

Animalia	Hemiptera	Aphididae	*Rhopalosiphum padi*	Linnaeus 1758	grasses, including cereals; Arecaceae; Cyperaceae; Iridaceae; Juncaceae; Typhaceae; dicots
*Animalia	Hemiptera	Aphididae	*Stagona pini*	Burmeister 1835	Rosaceae, monophagous
Animalia	Hemiptera	Aphididae	*Tetraneura ulmi*	Linnaeus 1758	Poaceae, oligophagous
*Animalia	Hemiptera	Aphididae	*Thecabius affinis*	Kaltenbach 1843	Salicaceae, monophagous
*Animalia	Hemiptera	Coccidae	*Asterodiaspis variolosa*	Ratzeburg 1870	Fagaceae, monophagous
Animalia	Hemiptera	Diaspididae	*Chionaspis salicis*	Linnaeus 1758	polyphagous on woody plants
Animalia	Hemiptera	Diaspiridae	*Cryptococcus fagisuga*	Lindinger 1936	Fagaceae, monophagous
Animalia	Hemiptera	Eryococcidae	*Psyllopsis fraxini*	Linnaeus 1758	Oleaceae, monophagous
Animalia	Hemiptera	Orthezidae	*Phylloxera foae*	Heyden 1837	Fagaceae, narrowly oligophagous
*Animalia	Hemiptera	Phylloxeridae	*Livia junci*	Schrank 1789	Juncaceae, monophagous
Animalia	Hemiptera	Phylloxeridae	*Phylloxera coccinea*	Heyden 1837	Fagaceae, narrowly oligophagous
*Animalia	Hemiptera	Phylloxeridae	*Phylloxera glabra*	Heyden 1837	Fagaceae, narrowly oligophagous
*Animalia	Hemiptera	Psyllidae	*Copium clavicorne*	Linnaeus 1758	Lamiaceae, monophagous
*Animalia	Hemiptera	Psyllidae	*Psylla buxi*	Linnaeus 1758	Buxaceae, monophagous
*Animalia	Hemiptera	Tingidae	*Trichochermes walkeri*	Foerster 1848	Rhamnaceae, monophagous
Animalia	Hemiptera	Triozidae	*Trioza apicalis*	Foerster 1848	Apiaceae, oligophagous
*Animalia	Hemiptera	Triozidae	*Trioza centranthi*	Vallot 1829	Caprifoliaceae, oligophagous
*Animalia	Hemiptera	Triozidae	*Trioza dispar*	Löw 1878	Asteraceae, oligophagous
*Animalia	Hemiptera	Triozidae	*Trioza flavipennis*	Förster 1848	Apiaceae, monophagous
*Animalia	Hemiptera	Triozidae	*Trioza proxima*	Flor 1861	Asteraceae, monophagous
Animalia	Hemiptera	Triozidae	*Trioza remota*	Foerster 1848	Fagaceae, monophagous
Animalia	Hemiptera	Triozidae	*Andricus callidoma*	Hartig 1841	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus coriarius*	Hartig 1843	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus corruptrix*	Schlechtendal 1870	Fagaceae, narrowly monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus curvator*	Hartig 1840	Fagaceae,monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus fecundatrix*	Hartig 1840	Fagaceae,monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus foecundatrix*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus gemmeus*	Giraud 1859	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus glandulae*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus grossulariae*	Giraud 1859	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus inflator*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus kollari*	Hartig 1843	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus lignicolus*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus malpighii*	Adler 1881	Fagaceae, monophagous

Animalia	Hymenoptera	Cynipidae	*Andricus paradoxus*	Radoszkowski 1866	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus quadrilineatus*	Hartig 1840	Fagaceae, monophagus
Animalia	Hymenoptera	Cynipidae	*Andricus quercuscalicis*	Burgsdorf 1783	Fagaceae, monophagus
Animalia	Hymenoptera	Cynipidae	*Andricus quercuscorticis*	Linnaeus 1761	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus quercusradicis*	Fabricius 1798	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus quercusramuli*	Linnaeus 1761	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Andricus quercustozae*	Bosc 1792	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Andricus rhyzomae*	Hartig 1843	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus seminationis*	Giraud 1859	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus solitaries*	Boyer de Fonscolombe 1832	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Andricus testaceipes*	Hartig 1840	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Aulacidea hieracii*	Bouché 1834	Asteraceae, narrowly oligophagous
*Animalia	Hymenoptera	Cynipidae	*Aylax minor*	Hartig 1840	Papaveraceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Aylax papaveris*	Perris 1839	Papaveraceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Biorhiza pallida*	Olivier 1791	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Callirhytis glandium*	Giraud 1859	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Callirhytis tumifica*	Osten Sacken 1865	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Cynips agama*	Hartig 1840	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Cynips corruptrix*	Schlechtendal 1870	Fagaceae, narrowly monophagous
Animalia	Hymenoptera	Cynipidae	*Cynips disticha*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Cynips divisa*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Cynips longiventris*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Cynips quercusfolii*	Linnaeus 1758	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Diastrophus rubi*	Bouché 1834	Rosaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Diplolepis eglanteriae*	Hartig 1840	Rosaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Diplolepis mayri*	Schlechtendal 1877	Rosaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Diplolepis nervosa*	Curtis 1838	Rosaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Diplolepis rosae*	Linnaeus 1758	Rosaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Diplolepis spinosissimae*	Giraud 1859	Rosaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Dryocosmus kuriphilus*	Yasumatsu 1951	Fagaceae, monophagou
*Animalia	Hymenoptera	Cynipidae	*Isocolus scabiosae*	Giraud 1859	Asteraceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Kiefferiola panteli*	Kieffer 1909	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Liposthenes glechomae*	Linnaeus 1758	Lamiaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Neuroterus albipes*	Schenck 1863	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Neuroterus albipes reflexus*	Kieffer 1901	Fagaceae, monophagous

Animalia	Hymenoptera	Cynipidae	*Neuroterus antracinus*	Curtis 1838	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Neuroterus numismalis*	Fourcroy 1785	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Neuroterus politus*	Hartig 1840	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Neuroterus quercusbaccerum*	Linnaeus 1758	Fagaceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Neuroterus tricolor*	Hartig 1841	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Phanacis centcuerae*	Förster 1860	Asteraceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Pediapsis aceri*	Hartig 1841	*Acer*
*Animalia	Hymenoptera	Cynipidae	*Timaspis cichorii*	Kieffer 1909	Asteraceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Timaspis lampsanae (=Phanacis l.)*	Perris 1873	Asteraceae, monophagous
Animalia	Hymenoptera	Cynipidae	*Trigonaspis megaptera*	Panzer 1801	Fagaceae, monophagous
*Animalia	Hymenoptera	Cynipidae	*Xestophanes potentillae*	Retzius in De Geer 1783	Rosaceae, monophagous
*Animalia	Hymenoptera	Tenthredinidae	*Blennocampa phyllocolpa*	Viitasaari & Vikberg 1985	Rosaceae, monophagous
*Animalia	Hymenoptera	Tenthredinidae	*Euura elaeagnocola (=Pontania e.)*	Kopelke 1994	Salicaceae, narrowly monophagous
Animalia	Hymenoptera	Tenthredinidae	*Euura oblita*	Audinet-Serville 1823	Salicaceae, narrowly monophagous
Animalia	Hymenoptera	Tenthredinidae	*Euura testaceipes*	Brischke 1883	Salicaceae, narrowly monophagous
*Animalia	Hymenoptera	Tenthredinidae	*Euura vesicator (=Pontania v.)*	Bremi-Wolf 1849	Salicaceae, narrowly monophagous
*Animalia	Hymenoptera	Tenthredinidae	*Euura viminalis*	Hartig 1837	Salicaceae, narrowly monophagous
Animalia	Hymenoptera	Tenthredinidae	*Phyllocolpa leucosticte*	Hartig 1837	Salicaceae, narrowly monophagous
Animalia	Hymenoptera	Tenthredinidae	*Euura triandrae*	Benson 1941	Salicaceae, narrowly monophagous
*Animalia	Hymenoptera	Tenthredinidae	*Pontania pedunculi*	Hartig 1837	Salicaceae, narrowly monophagous
Animalia	Lepidoptera	Momphidae	*Mompha sturnipennella*	Treitschke 1833	Onagraceae, monophagous
Animalia	Lepidoptera	Tortricidae	*Retinia resinella*	Linnaeus 1758	Pinaceae, monophagous
Animalia	Lepidoptera	Tortricidae	*Rhyacionia buoliana*	Denis & Schiffermüller 1775	Pinaceae, monophagous (?)
Animalia	Rhabditida	Anguinidae	*Ditylenchus dipsaci*	Kühn 1857	strongly polyphagous on herbaceous plants
Animalia	Rhabditida	Heteroderidae	*Heterodera schachtii*	Schmidt 1871	polyphagous
Animalia	Rhabditida	Meloidogynidae	*Meloidogyne hapla*	Chitwood 1949	broadly polyphagous
Animalia	Rhabditida	Meloidogynidae	*Meloidogyne incognita*	Kofoid & White 1919	*Begonia; Impatiens; Lycopersicon esculentum; Medicago; Nicotiana tabacum; Vitis.*
Animalia	Trombidiformes	Eriophyidae	*Acalitus brevitarsus*	Fockeu 1890	Betulaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Acalitus calycophthirus*	Nalepa 1891	Betulaceae,monophagous
Animalia	Trombidiformes	Eriophyidae	*Acalitus essigi*	Hassan 1928	Rosaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria fraxinivora*	Nalepa 1909	Oleaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Acalitus longisetosus*	Nalepa 1892	Betulaceae,? monophagous
Animalia	Trombidiformes	Eriophyidae	*Acalitus phyllereus*	Nalepa 1919	Betulaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Acaphyllisa salicobia*	Nalepa 1892	Salicaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Acaricalus trinotus*	Nalepa 1892	Betulaceae, monophagous

*Animalia	Trombidiformes	Eriophyidae	*Aceria cephalonea*	Nalepa 1922	Sapindaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria dispar*	Nalepa 1891	Salicaceae, narrowly monophagous
*Animalia	Trombidiformes	Eriophyidae	*Aceria erinea*	Nalepa 1891	Juglandaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria galiobia*	Canestrini 1891	Rubiaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria genistae*	Nalepa 1892	Fabaceae, narrowly oligophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria lycopersici*	Wolffenstein 1879	Solanaceae, narrowly oligophagous
*Animalia	Trombidiformes	Eriophyidae	*Aceria macrochela*	Nalepa 1891	Sapindaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria macrocheluserinea*	Trotter 1902	Sapindaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria macrorhyncha*	Nalepa 1889	Sapindaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria myriadeum*	Murray 1877	Sapindaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria nervisequa*	Canestrini 1891	Fagaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria peucedani*	Canestrini 1892	Apiaceae, oligophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria pseudoplatani*	Corti 1905	Sapindaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Aceria quercina*	Canestrini 1891	Fagaceae, narrowly monophagous
*Animalia	Trombidiformes	Eriophyidae	*Aceria salviae*	Nalepa 1891	Lamiaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Aceria tenella*	Nalepa 1892	Betulaceae, oligophagous
Animalia	Trombidiformes	Eriophyidae	*Aculops macrotrichus*	Nalepa 1889	Betulaceae, oligophagous
Animalia	Trombidiformes	Eriophyidae	*Aculus fraxini*	Nalepa 1894	Oleaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aculus laevis*	Nalepa 1892	Salicaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Aculus xylostei*	Canestrini 1892	Caprifoliaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Callyntrotus trilobus*	Nalepa 1923	Adoxaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Cecidophyes nudus*	Nalepa 1891	Rosaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Colomerus vitis*	Pagenstecher 1857	Vitaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Epitrimerus marginemtorquens*	Nalepa 1917	Rosaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes exilis*	Nalepa 1892	Malvaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Eriophyes diversipunctatus*	Nalepa 1890	Salicaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes inangulis*	Nalepa 1919	Betulaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes laevis*	Nalepa 1889	Betulaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Eriophyes leionotus*	Nalepa 1891	Betulaceae, narrowly monophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes prunianus*	Nalepa 1926	Rosaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes pyri*	Pagenstecher 1857	Rosaceae, oligophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes similis*	Nalepa 1890	Rosaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Eriophyes sorbi*	Pagenstecher 1857	Rosaceae, oligophagous
Animalia	Trombidiformes	Eriophyidae	*Eriophyes tiliae*	Pagenstecher 1857	Malvaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Phyllocoptes populi*	Nalepa 1894	Salicaceae, monophagous

Animalia	Trombidiformes	Eriophyidae	*Phyllocoptes sorbeus*	Nalepa 1926	Rosaceae, monophagous
*Animalia	Trombidiformes	Eriophyoidae	*Stenacis euonymi*	Frauenfeld 1865	Celastraceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Tegonotus heptacanthus*	Nalepa 1889	Betulaceae, monophagous
Animalia	Trombidiformes	Eriophyidae	*Tegonotus trouessarti*	Nalepa 1892	Betulaceae, monophagous
*Animalia	Trombidiformes	Eriophyidae	*Vasates quadripedes*	Shimer 1869	Sapindaceae, narrowly monophagous
Animalia	Trombidiformes	Phytoptidae	*Phytoptus avellanae*	Nalepa 1889	Betulaceae, monophagous
*Animalia	Trombidiformes	Tarsonemidae	*Steneotarsonemus phragmitidis*	Schlechtendal 1898	Poaceae, monophagous
Bacteria	Acholeplasmatales	Acholeplasmataceae	*Candidatus Phytoplasma*		
Bacteria	Acholeplasmatales	Acholeplasmataceae	*Candidatus Phytoplasma asteris*		
*Bacteria	Mycobacteriales	Frankiaceae	*Frankia alni*	Tubeuf 1895	Betulaceae, monophagous
*Bacteria	Mycobacteriales	Frankiaceae	*Frankia sp.*		
*Bacteria	Pseudomonadales	Pseudomonadaceae	*Pseudomonas savastanoi pv. Forsythiae*	Smith 1908, Stevens 1913	Oleaceae, oligophagous
Bacteria	Rhizobiales	Rhizobiaceae	*Agrobacterium tumefasians*	Smith & Townsend 1907 Conn 1942	strongly polyphagous
Fungi	Albuginales	Albuginaceae	*Albugo candida*	Roussel 1806	Brassicaceae; Capparaceae; Resedaceae, narrowly polyphagous
Fungi	Albuginales	Albuginaceae	*Albugo lepidii*	Rao 1980	Brassicaceae-Lepidieae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Arthrocladiella mougeotii*	Vassilkov 1963	Solanaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Blumeria graminis*	Speer 1975	Poaceae, broadly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe adunca*	Fries 1829	Salicaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe aquilegiae*	de Candolle 1815	Ranunculaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe aquilegiae var. ranunculi*	Zhang & Chen 1981	Ranunculaceae, almost monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe arcuata*	Braun, Heluta & Takamatsu 2006	Betulaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe azaleae*	Braun & Takamatsu 2000	Ericaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe berberidis*	de Candolle 1805	Berberidaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe buhrii*	Braun 1978	Caryophyllaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe capreae*	de Candolle 1830	Salicaceae, narrowly monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe circaeae*	Junell 1967	Onagraceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe convolvuli*	de Candolle 1815	Convolulaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe cruciferarum*	Opiz 1967	Brassicaceae; Cleomaceae; Papaveraceae; Resedaceae, broadly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe deutziae*	Braun & Takamatsu 2000	Hydrangeaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe elevata*	Braun & Takamatsu 2000	Bignoniaceeae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe euonymi*	de Candolle 1815	Celastraceae, monophagous

Fungi	Erysiphales	Erysiphaceae	*Erysiphe euonymicola*	Braun 2012	Celastraceae, narrowly monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe flexuosa*	Braun & Takamatsu 2000	Sapindaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe grossulariae*	de Bary 1870	Grossulariaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe heraclei*	Wallroth 1819	Apiaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe howeana*	Braun 1982	Onagraceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe hyperici*	Blumer 1933	Hypericaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe knautiae*	Duby 1830	Caprifoliaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe lonicerae*	de Candolle 1815	Caprifoliaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe lycopsidis*	Zheng & Chen 1981	Boraginacaeae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe lythri*	Junell 1967	Lythraceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe necator*	Schweinitz 1834	Vitaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe ornata*	Braun & Takamatsu 2000	Betulaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe paeoniae*	Zheng & Chen 1981	Paeoniaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe palczewskii*	Braun & Takamatsu, 2000	Fabaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe penicillata*	Link 1824	Betulaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe pisi*	de Candolle 1805	Fabaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe platani*	Braun & Takamatsu 2000	Platanaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe polygoni*	de Candolle 1821	Polygonaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe prunastri*	de Candolle 1815	Rosaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe russellii*	Braun & Takamatsu 2000	Oxalidaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe symphoricarpi*	Braun & Takamatsu 2000	Caprifoliaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe syringae*	Schweinitz 1834	Oleaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe syringae-japonicae*	Braun & Takamatsu 2000	Oleaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe thesii*	Junell 1967	Santalaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe trifoliorum*	Braun 2010	Fabaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe ulmariae*	Desmazières 1846	Rosaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe ulmi*	Castagne 1845	Ulmaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe urticae*	Blumer 1933	Urticaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe vanbruntiana*	Braun & Takamatsu 2000	Adoxaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Erysiphe viburni*	Duby 1830	Adoxaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces ambrosiae*	Braun & Cook 2009	Asteraceae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces artemisiae*	Heluta 1988	Asteraceae, almost monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces asterum var. solidaginis*	Braun 2012	Asteraceae, ? oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces biocellatus*	Heluta 1988	Lamiaceae; Nepetoideae, narrowly oligophagous

Fungi	Erysiphales	Erysiphaceae	*Golovinomyces cichoracearum*	Heluta 1988	Asteraceae; Cichoreae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces depressus*	Heluta 1988	Asteraceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces echinopis*	Heluta 1988	Asteraceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces fischeri*	Braun & Cook 2009	Asteraceae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces inulae*	Braun & Shin 2012	Asteraceae; Inuleae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces macrocarpus*	Braun 2012	Asteraceae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces magnicellulatus*	Heluta 1988	Polemoniaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces monardae*	Scholler, Braun & Schmidt 2016	Lamiaceae; Nepetoideae; Verbenaceae, narrowly polyphagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces montagnei*	Braun 2012	Asteraceae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces neosalviae*	Scholler, Braun & Schmidt 2016	Lamiaceae; Nepetoideae, narrowly monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces orontii*	Heluta 1988	dicotyledons, broadly polyphagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces prenanthis*	Braun 2012	Asteraceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces salviae*	Scholler, Braun & Schmidt 2016	Lamiaceae; Nepetoideae, narrowly monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces senecionis*	Braun 2012	Asteraceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces sonchicola*	Braun & Cook 2009	Asteraceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Golovinomyces verbasci*	Heluta 1988	Scrophulariaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Leveillula duriaei*	Braun 1984	Lamiaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Leveillula taurica*	Arnaud 1921	broadly polyphagous
Fungi	Erysiphales	Erysiphaceae	*Neoërysiphe galeopsidis*	Heluta 1988	Acanthaceae; Bignoniaceae; Lamiaceae; Malvaceae, polyphagous
Fungi	Erysiphales	Erysiphaceae	*Neoërysiphe galii*	Braun 1999	Rubiaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia betulae*	Fuss 1878	Betulaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia carpini*	Fuss 1878	Betulaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia fraxini*	Fuss 1878	Oleaceae; Apocynaceae; Fabaceae, essentially oligophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia guttata*	Léveillé 1851	Betulaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia mali*	Braun 1978	Rosaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia orbicularis*	Braun 2012	Fagaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Phyllactinia populi*	Yu 1979	Salicaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera amelanchieris*	Maurizio 1927	Rosaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera aphanis*	Braun & Takamatsu 2000	Rosaceae; Gentianaceae; Myrtaceae, polyphagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera balsaminae*	Braun & Takamatsu 2000	Balsaminaceae, narrowly monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera clandestina*	Léveillé 1851	Rosaceae, oligophagous

Fungi	Erysiphales	Erysiphaceae	*Podosphaera dipsacacearum*	Braun & Takamatsu 2000	Caprifoliaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera epilobii*	de Bary 1870	Onagraceae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera erigerontis-canadensis*	Braun & Liu 2010	Asteraceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera euphorbiae*	Braun & Takamatsu 2000	Euphorbiaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera ferruginea*	Braun & Takamatsu 2000	Rosaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera filipendulae*	Liu & Braun 2010	Rosaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera fugax*	Braun & Takamatsu 2000	Geraniaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera fuliginea*	Braun & Takamatsu 2000	Plantaginaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera fusca*	Braun & Shishkoff 2000	Asteraceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera helianthemi*	Braun & Takamatsu 2000	Cistaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera leucotricha*	Salmon 1900	Rosaceae, oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera macularis*	Braun & Takamatsu 2000	Cannabaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera mors-uvae*	Braun & Takamatsu 2000	Grossulariaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera myrtillina*	Kunze 1823	Ericaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera pannosa*	de Bary 1870	Rosaceae, oligopgous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera phtheirospermi*	Braun & Liu 2010	Orobanchaceae; Scrophulariaceae, narrowly polyphagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera plantaginis*	Braun & Takamatsu 2000	Plantaginaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera senecionis*	Braun 2012	Asteracae, narrowly oligophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera spiraeae*	Braun & Takamatsu 2000	Rosaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera tridactyla*	de Bary 1870	Rosaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Podosphaera xanthii*	Braun & Shishkoff 2000	polyphagous
Fungi	Erysiphales	Erysiphaceae	*Pseudoidium hortensiae*	Braun & Cook 2012	Hydrangeaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Sawadaea bicornis*	Homma 1937	Sapindaceae, monophagous
Fungi	Erysiphales	Erysiphaceae	*Sawadaea tulasnei*	Homma 1937	Sapindaceae, monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium expansum*	Nannfeldt 1981	Ericaceae, narrowly monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium japonicum*	Shirai 1896	Ericaceae, monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium juelianum*	Nannfeldt 1981	Ericaceae, narrowly monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium karstenii*	Saccardo & Trotter 1912	Ericaceae, monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium myrtilli*	Siegmund 1879	Ericaceae, narrowly monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium oxycocci*	Rostrup 1907	Ericaceae, narrowly monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium pachysporum*	Nannfeldt 1981	Ericaceae, narrowly monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium rostrupii*	Nannfeldt 1981	Ericaceae, narrowly oligophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium vaccinii*	Woronin 1867	Ericaceae, narrowly monophagous
Fungi	Exobasidiales	Exobasidiaceae	*Exobasidium vaccinii-uliginosi*	Boudier 1894	Ericaceae, narrowly monophagous

Fungi	Helotiales	Drepanopezizaceae	*Diplocarpon rosae*	Wolf 1912	Rosaceae, monophagous
Fungi	Helotiales	Drepanopezizaceae	*Leptotrochila astrantiae*	Schüepp 1959	Apiaceae, monophagous
Fungi	Helotiales	Drepanopezizaceae	*Leptotrochila verrucosa*	Schüepp 1959	Rubiaceae, oligophagous
Fungi	Helotiales	Lachnaceae	*Lachnellula willkommii*	Dennis 1962	Pinaceae, monophagous
Fungi	Helotiales	Ploettnerulaceae	*Pseudopeziza trifolii*	Fuckel 1870	Fabaceae, monophagous
Fungi	Helotiales	Sclerotiniaceae	*Cristulariella depraedans*	Höhnel 1916	Sapindaceae, etc.
Fungi	Helotiales	Sclerotiniaceae	*Monilinia fructigena*	Honey 1945	Rosaceae, narrowly oligophagous
Fungi	Helotiales	Sclerotiniaceae	*Monilinia johnsonii*	Honey 1936	Rosaceae, monophagous
Fungi	Hypocreales	Clavicipitaceae	*Claviceps purpurea*	Tulasne 1853	Poaceae, oligophagous
Fungi	Hypocreales	Clavicipitaceae	*Epichloe bromicola*	Leuchtmann & Schardl 1998	Poaceae, monophagous
Fungi	Hypocreales	Clavicipitaceae	*Epichloe clarkii*	White 1993	Poaceae, monophagous
Fungi	Hypocreales	Clavicipitaceae	*Epichloe typhina*	Tulasne 1865	Poaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum anomalum*	Vánky 1998	Polygonaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum betonicae*	Bauer & Oberwinkler 1997	Laminaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum coronariae*	Denchev 2011	Caryophyllaceae, narrowly monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum dianthorum*	Scholz 1988	Caryophyllaceae, narrowly oligophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum intermedium*	Vánky 1998	Caprifoliaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum lagerheimii*	Denchev 2007	Caryophyllaceae, narrowly monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum lychnidis-dioicae*	Deml & Oberwinkler 1982	Caryophyllaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum majus/major*	Deml & Oberwinker 1982	Carylophyllaceae, narrowly monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum pustulatum*	Bauer & Oberwinkler 1997	Polygonaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum reticulatum*	Bauer & Oberwinkler 1997	Polygonaceae, narrowly monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum salviae*	Kemler & Lutz 2007	Laminaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum saponariae*	Lutz, Göker, Piątek, Kemler, Begerow & Oberwinkler 2005	Caryophyllaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum scabiosae*	Deml & Prillinger 1991	Caprifoliaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum scorzonerae*	Deml & Prillinger 1991	Asteraceae; Cichoreaea, narrowly oligophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum silenes-dioicae*	Giraud, Denchev & Hood 2009	Caryophyllaceae, narrowly monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum silenes-inflatae*	Deml & Oberwinkler 1982	Caryophyllaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum stellariae*	Deml & Oberwinkler 1982	Caryophyllaceae, narrowly oligophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum stygium*	Vánky 1998	Polygonaceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum tragopogonis-pratensis*	Bauer & Oberwinkler 1997	Asteraceae, monophagous
Fungi	Microbotryales	Microbotryaceae	*Microbotryum violaceum*	Deml & Oberwinkler 1982	Caryophyllaceae, oligophagous

Fungi	Microbotryales	Microbotryaceae	*Sphacelotheca hydropiperis*	de Bary 1884	Polygonaceae, monophagous
Fungi	Microbotryales	Ustilentomataceae	*Ustilentyloma fluitans*	Vánky 1970	Poaceae, monophagous
Fungi	Peronosporales	Peronosporaceae	*Bremia lactucae*	Regel 1843	Asteraceae, broadly oligophagous
Fungi	Peronosporales	Peronosporaceae	*Hyaloperonospora parasitica*	Constantinescu 2002	Brassicaceae; (Cleomaceae), narrowly polyphagous
Fungi	Pucciniales	-	*Uredo hyperici-humifusi*	Klebahn 1914	Hypericaceae, narrowly monophagous
Fungi	Pucciniales	Coleosporiaceae	*Chrysomyxa abietis*	Unger 1840	Pinaceae, monophagous
Fungi	Pucciniales	Coleosporiaceae	*Chrysomyxa pyrolae*	Rostrup 1881	Pinaceae, monophagous; Ericaceae, narrowly oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium cacaliae*	Léveillé 1847	Pinaceae, moniophagous; Asteraceae, oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium campanulae*	Léveillé 1847	Pinaceae, monophagpous; Campanulaceae, oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium euphrasiae*	Winter 1881	Pinaceae, monophagous; Orobanchaceae, oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium inulae*	Rabenhorst 1851	Pinaceae, monophagous; Asteraceae Inuleae, oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium melampyri*	Klebahn 1854	Pinaceae, monophagpous; Orobanchaceae, monophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium petasitis*	de Bary 1865	Pinaceae, monophagous; Asteraceae, monophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium pulsatillae*	Fries 1849	Pinaceae, monophagous; Ranunculaceae, narrowly oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium senecionis*	Fries 1867	Pinaceae, monophagous; Asteraceae, oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium sonchi*	Léveillé 1854	Pinaceae, monophagous; Asteraceae, oligophagous
Fungi	Pucciniales	Coleosporiaceae	*Coleosporium tussilaginis*	Léveillé 1849	Pinaceae, monophagous
Fungi	Pucciniales	Cronartiaceae	*Cronartium flaccidum*	Winter 1880	Pinaceae, monophagous; herbs, strongly polyphagous
Fungi	Pucciniales	Cronartiaceae	*Cronartium ribicola*	Fischer 1872	Pinaceae, monophagous; polyphagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora allii-fragilis*	Klebahn 1901	Amaryllidacae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora allii-populina*	Klebahn 1902	Amaryllidaceae; Araceae; Asparagaceae, polyphagous; Salicaceae, monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora amygdalinae*	Klebahn 1909	Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora arctica*	Thümen 1879	Saxifragaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora caprearum*	Thümen 1879	Pinaceae, monophagous; Salicaceae, monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora euonymi-caprearum*	Klebahn 1900	Celastraceae, monophagous; Salicaceae, narrowly monophagous

Fungi	Pucciniales	Melampsoraceae	*Melampsora euphorbiae*	Castagne 1843	Euphorbiaceae, monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora euphorbiae-dulcis*	Otth 1868	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora helioscopiae*	Winter 1881	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora hypericorum*	Schröter 1871	Hypericaceae, monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora laricis-epitea*	Klebahn 1899	Pinaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora laricis-populina*	Klebahn 1902	Pinaceae, monophagous; Salicaceae, monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora laricis-tremulae*	Klebahn 1897	Pinaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora lini*	Thümen 1878	Linaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora pinitorqua*	Rostrup 1889	Pinaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora populnea*	Karsten 1879	Pinaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora ribesii-epitea*	Klebahn 1914	Grossulariaceae, monophagous, Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora ribesii-purpureae*	Klebahn 1901	Grossulariaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora ribesii-viminalis*	Klebahn 1900	Grossulariaceae, monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora rostrupii*	Wagner 1896	Euphorbiaceae, narrowly monophagous; Salicaceae, narrowly monophagous
Fungi	Pucciniales	Melampsoraceae	*Melampsora salicis-albae*	Klebahn 1901	Amaryllidaceae, monophagous; Salicaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Kuehneola uredinis*	Arthur 1906	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium bulbosum*	Schlechtendal 1824	Rosaceae, broadly monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium candicantium*	Dietel 1927	Rosaceae, narrowly monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium fragariae*	Winter 1884	Rosaceae, narrowly oligophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium fusiforme*	Schröter 1870	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium mucronatum*	Schlechtendal 1824	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium potentillae*	Karsten 1879	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium rubi-idaei*	Karsten 1879	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium sanguisorbae*	Schröter 1887	Rosaceae, narrowly oligophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium tuberculatum*	Julius Müller 1885	Rosaceae, narrowly oligophagous
Fungi	Pucciniales	Phragmidiaceae	*Phragmidium violaceum*	Winter 1880	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Trachyspora alchemillae*	Fuckel 1861	Rosaceae, monophagous
Fungi	Pucciniales	Phragmidiaceae	*Xenodochus carbonarius*	Schlechtendal 1826	Rosaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Aecidium euphorbiae*	Persoon 1792	Euphorbiaceae, monophagous

*Fungi	Pucciniales	Pucciniaceae	*Aecidium clematidis*	Candolle 1805	Ranunculaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Aecidium ranunculi-acris*	Persoon 1800	Ranunculaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Aecidium succisae*	Kirchner 1856	Caprifoliaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Aecidium thalictri*	Greville 1823	Ranunculaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Cumminsiella mirabilissima*	Nanffeldt 1947	Berberidaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Endophyllum euphorbiae-silvaticae*	Winter 1881	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Endophyllum sempervivi*	de Bary 1863	Crassulaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Frommeëlla mexicana*	McCain & Hennen 1990	Rosaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Frommeella tormentillae*	Cummins & Hiratsuka 1983	Rosaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Gymnosporangium amelanchieris*	Fischer 1909	Rosaceae, narrowly oligophagous; Cupressaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Gymnosporangium clavariiforme*	de Candolle 1805	woody Rosaceae, oligophagous; Cupressaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Gymnosporangium confusum*	Plowright 1889	woody Rosaceae (Maloideae), oligophagous; Cupressaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Gymnosporangium cornutum*	Arthur 1911	Rosaceae, monophagous; Cupressaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Gymnosporangium sabinae*	Winter 1884	Rosaceae, monophagous; Cupressaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Gymnosporangium tremelloides*	Hartig 1882	Rosaceae, monophagous; Cupressaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia absinthii*	de Candolle 1808	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia acetosae*	Körnicke 1876	Polygonaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia aconiti-rubrae*	Lüdi 1918	Ranunculaceae, monophagous; Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia actaeae-agropyri*	Fischer 1901	Rancunlaceae, oligophagous; Poaceae, ? monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia actaeae-elymi*	Mayor 1911	Rancunlaceae, oligophagous; Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia adoxae*	Hedwig 1805	Adoxaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia aecidii-leucanthemi*	Fischer 1898	Asteraceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia aegopodii*	Link 1817	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia agropyri*	Ellis & Everhart 1892	Rancunlaceae, monophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia agropyrina*	Eriksson 1899	Rancunlaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia agrostidis*	Plowright 1890	Rancunlaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia albescens*	Greville 1889	Adoxaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia allii*	Rudolphi 1829	Amaryllidaceae, monophagous

Fungi	Pucciniales	Pucciniaceae	*Puccinia alnetorum*	Gäumann 1941	Rancunlaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia alternans*	Arthur 1910	Rancunlaceae, monophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia angelicae*	Fuckel 1870	Apiaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia annularis*	Winter 1881	Lamiacae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia anthoxanthina*	Gäumann 1945	Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia antirrhini*	Dietel & Holway 1897	Plantaginaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia arenariae*	Schröter 1880	Caryophyllaceae; Montiaceae; Molluginaceae, narrowly polyphagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia arrhenatheri*	Eriksson 1898	Berberidaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia asarina*	Kunze 1817	Aristolochiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia asparagi*	de Candolle 1815	Asparagaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia asperulae-odoratae*	Wurth 1904	Rubiaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia astrantiae*	Kalchbrenner 1865	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia athamantina*	Sydow & Sydow 1902	Apiaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia bardanae*	Corda 1840	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia behenis*	Otth 1871	Caryophyllaceae, broadly
Fungi	Pucciniales	Pucciniaceae	*Puccinia betonicae*	de Candolle 1815	Lamiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia bistortae*	de Candolle 1815	Apiaceae, oligophagous; Polygonaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia brachycyclica*	Fischer 1934	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia brachypodii*	Otth 1861	Berberidaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia bromina*	Eriksson 1899	Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia bupleuri*	Rudolphi 1829	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia buxi*	Sowerby 1809	Buxaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia calthicola*	Schröter 1879	Ranunculaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia carduorum*	Jacky 1899	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia caricina*	de Candolle 1815	Grossulariaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia caricina var. ribis-ferrugineae*	Zwetko 1993	Grossulariaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia caricis-montanae*	Fischer 1898	Asteraceae, nauw oligophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia carlinae*	Jacky 1899	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia centaureae*	de Candolle 1815	Asteraceae, narrowly oligoophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia cervariae*	Lindroth 1901	Apiaceae, narrowly monophagous

Fungi	Pucciniales	Pucciniaceae	*Puccinia cesatii*	Schröter 1879	Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia chaerophylli*	Purton 1821	Apiaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia chamaedryos*	Cesati 1832	Lamiacae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia chondrillae*	Corda 1840	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia chondrillina*	Bubák 1901	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia chrysosplenii*	Greville 1836	Saxifragaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia circaeae*	Persoon 1794	Onagraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia circaeae-caricis*	Hasler 1930	Onagraceae, oligophagous; Cyperaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia cnici*	Martius 1817	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia cnici-oleracei*	Persoon 1823	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia coaetanea*	Bubák 1905	Rubiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia conii*	Fuckel 1870	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia constricta*	Bubák 1900	Lamiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia convolvuli*	Castagne 1842	Convolvulaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia coronate*	Corda 1837	Rhamnaceae, narrowly oligophagous; Poaceae, broadly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia corrigiolae*	Chevallier 1826	Molluginaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia crepidicola*	Sydow 1901	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia crepidis*	Schröter 1887	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia crepidis-pygmaeae*	Gaillard 1887	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia cribrata*	Arthur & Cummins 1933	Apocynaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia cyani*	Passerini 1874	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia deschampsiae*	Arthur 1910	Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia difformis*	Kunze 1917	Rubiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia dioicae*	Magnus 1877	Asteraceae, oligophagous; Cyperaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia divergens*	Bubák 1907	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia echinopis*	de Candolle 1815	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia fergussonii*	Berkeley & Broome 1875	Violaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia festucae*	Plowright 1893	Caprifoliaceae, monophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia fuckelii*	Sydow & Sydow 1902	Juncaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia galii-verni*	Cesati 1846	Rubiaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia gentianae*	Link 1924	Gentianaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia gibberosa*	Lagerheim 1888	Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia glechomatis*	de Candolle 1808	Lamiaceae, monophagous

Fungi	Pucciniales	Pucciniaceae	*Puccinia globulariae*	de Candolle 1815	Plantaginaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia graminis*	Persoon 1794	Berberidaceae, oligophagous; Poaceae, broadly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia heraclei*	Greville 1823	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia holcina*	Eriksson 1899	Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia hordei*	Otth 1871	Asparagaceae, oligophagous; Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia huteri*	Sydow & Sydow 1901	Saxifragaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia hypochaeridis*	Oudemans 1873	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia hysterium*	Röhling 1813	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia intybi*	Sydow 1901	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia iridis*	Wallroth 1844	Caprifoliaceae; Urticaceae; narrowly polyphagous; Iridaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia jaceae*	Otth 1866	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia komarovii*	Tranzschel 1936	Balsaminaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia lagenophorae*	Cooke 1884	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia lapsanae*	Fuckel 1860	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia laschii*	Lagerheim 1895	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia leontodontis*	Jacky 1899	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia liliacearum*	Duby 1830	Amaryllidaceae; Asparagaceae, narrowly polyphagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia linosyridis-caricis*	Fischer 1904	Asteraceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia loliicola*	Viennot-Bourgin 1937	Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia luzulae*	Libert 1830	Juncaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia lycoctoni*	Fuckel 1875	Ranunculceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia maculosa*	Schweinitz 1834	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia magnusiana*	Körnicke 1876	Ranunclaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia major*	Dietel 1894	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia malvacearum*	Bertero 1852	Malvaceae, broadly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia melicae*	Sydow & Sydow 1903	Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia menthae*	Persoon 1801	Lamiaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia millefolii*	Fuckel 1870	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia mulgedii*	Sydow 1902	Asteraceae, narrowly monophagpus
Fungi	Pucciniales	Pucciniaceae	*Puccinia nemoralis*	Juel, 1894	Orobanchaceae, monophagous; Poaceae, monophagous

Fungi	Pucciniales	Pucciniaceae	*Puccinia nitida*	Barclay 1890	Apiaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia obscura*	Schröter 1877	Asteraceae, monophagous; Juncaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia opizii*	Bubák 1902	Asteraceae, narrowly oligophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia oreoselini*	Körnicke 1869	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pedunculata*	Doidge 1926	Polygonceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia perplexans*	Plowright 1885	Ranunculaceae, narrowly monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pelargonii-zonalis*	Doidge 1926	Geraniaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia persistens*	Plowright 1889	Ranunculaceae, narrowly monophagous; Poaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia petasites-pendulae*	Gäumann 1943	Asteraceae, narrowly oligophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia petasites-poarum*	Gäumann & Eichhorn 1941	Asteraceae, monophagous; Poaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia petasites-pulchellae*	Lüdi 1916	Asteraceae, monophagous; Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia phragmitis*	Körnicke 1876	Polygonaceae, oligophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia picridis*	Hazslinkszky 1877	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia piloselloidearum*	Probst 1909	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pimpinellae*	Link 1824	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia poae-nemoralis*	Otth 1871	Berberidaceae, monophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia poarum*	Nielsen 1877	Asteraceae, monophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia polygoni-amphibii*	Persoon 1801	Geraniaceae, oligophagous; Polygonaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pozzii*	Semadeni 1904	Apiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia praecox*	Bubák 1898	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pratensis*	Blytt 1896	Poaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pringsheimiana*	Klebahn 1895	Grossulariaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pulsatillae*	Kalchbrenner 1865	Ranunculaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pulverulenta*	Gréville 1824	Onagraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia punctata*	Link 1816	Rubiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pygmaea*	Eriksson 1895	Berberidaceae, narrowly oligophagous; Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia pyrethri*	Rabenhorst 1880	Asteraceae, narrowly oligophagous

Fungi	Pucciniales	Pucciniaceae	*Puccinia recondita*	Dietel & Holway 1857	Boraginaceae?, monophagous; Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia retifera*	Lindroth 1902	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia ribis*	de Candolle 1805	Grossulariaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia rossiana*	Lagerheim 1890	Asparagaceae, ? monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia saniculae*	Greville 1824	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia saxifragae*	Schlechtendal 1824	Saxifragaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia schoeleriana*	Plowright & Magnus 1885	Asteraceae, narrowly oligophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia scillae-rubrae*	Cruchet 1917	Asparagaceae, narrowly monophagous; Poaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia scirpi*	de Candolle 1805	Menyanthaceae, monophagous; Cyperaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia semadenii*	Gäumann 1941	Apiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia senecionis*	Libert 1830	Asteraceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia senecionis-acutiformis*	Hasler, Mayor & Cruchet 1922	Asteraceae, narrowly oligophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia sesleriae*	Reichardt 1877	Rhamnaceae, narrowly monophagous; Poaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia sessilis*	Schröter 1870	Amaryllidaceae; Araceae; Asparagaceae; Melianthaceae; Orchidaceae, narrowly polyphagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia sii-falcariae*	Schröter 1887	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia silai*	Fuckel 1870	Apiaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia silvatica*	Schröter 1879	Asteraceae, oligophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia sorghi*	Schweinitz 1834	Oxalidaceae, narrowly monophagous; Poaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia stachydis*	de Candolle 1805	Lamiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia striiformis*	Westendorp 1854	Berberidaceae, monophagous; Poaceae, broadly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia suaveolens (Puccinia punctiformis)*	Röhl 1813	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia striiformis*	Westendorp 1854	Poaceae, broadly oligophagous; Berberidaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia symphyti-bromorum*	Müller 1901	Boraginaceae, oligophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia tanaceti*	de Candolle 1805	Asteraceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia taraxaci*	Plowright 1889	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia thesii*	Chaillet 1830	Santalaceae, monophagous

Fungi	Pucciniales	Pucciniaceae	*Puccinia thlaspeos*	Ficinus & Schubert 1823	Brassicaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia tirolensis*	Zwetko 1993	Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia triseti*	Eriksson 1899	Crassulaceae, narrowly monophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia triticina*	Eriksson 1899	Poaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia uliginosa*	Juel 1894	Celastraceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia urticae-acutiformis*	Gäumann 1959	Urticaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia urticae-flaccae*	Hasler 1945	Urticaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia urticae-hirtae*	Klebahn 1899	Urticaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia urticae-inflatae*	Hasler 1925	Urticaceae, monophagous; Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia urticata*	Kern 1917	Urticaceae, monophagous; Cyperaceae monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia variabilis*	Greville 1824	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia veronicae*	Winter 1884	Plantaginaceae, narrowly monophagous
*Fungi	Pucciniales	Pucciniaceae	*Puccinia veronicarum*	de Candolle 1805	Plantaginaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia violae*	de Candolle 1815	Violaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Puccinia vulpinae*	Schröter 1874	Asteraceae, narrowly oligophagous, Cyperaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Tranzschelia pruni-spinosae*	Dietel 1922	Ranunculaceae, narrowly monophagous; Rosaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces acetosae*	Schröter 1876	Polygonaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces acutatus*	Fuckel 1870	Asparagaceae; Liliaceae, narrowly polyphagpous
Fungi	Pucciniales	Pucciniaceae	*Uromyces aecidiiformis*	Rees 1917	Liliaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces airae-flexuosae*	Ferdinandsen & Winge 1920	Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces anthyllidis*	Schröter 1875	Euphorbiaceae, narrowly monophagous; Fabaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces armeriae*	Léveillé 1847	Plumbaginaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces beticola*	Boerema, Loerakker & Hamers 1987	Amaranthaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces cacaliae*	Unger 1836	Asteraceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces caraganicola*	Hennnings 1901	Euphorbiaceae, narrowly monophagous; Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces cristulatus*	Tranzschel 1910	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces dactylidis*	Otth 1861	Ranunculaceae, broadly monophagous; Poaceae, oligophagous

Fungi	Pucciniales	Pucciniaceae	*Uromyces dianthi*	Niessl 1872	Euphorbiaceae, narrowly monophagous; Caryophyllaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces ervi*	Westendorp 1854	Fabaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces euphorbiae-corniculatae*	Jordi 1904	Euphorbiaceae, narrowly monophagous; Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces excavatus*	Magnus 1847	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces ficariae*	Léveillé 1860	Ranunculaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces fischeri-eduardi*	Magnus 1907	Euphorbiaceae, narrowly monophagous; Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces flectens*	Lagerheim 1909	Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces gageae*	Beck 1880	Liliaceae, ? monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces genistae*	Fuckel 1870	Euphorbiaceae, narrowly monophagous; Fabaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces geranii*	Otth & Wartmann 1847	Geraniaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces inaequialtus*	Lasch 1851	Caryophyllaceae, broadly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces junci*	Tulasne 1854	Asteraceae, narrowly oligophagous; Juncaceae, broadly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces kabatianus*	Bubák 1902	Geraniaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces kalmusii*	Saccardo 1880	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces laburni*	Otth 1864	Euphorbiaceae, narrowly monophagous; Fabaceae, ? monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces laevis*	Körnicke 1877	Euphorbia, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces lineolatus*	Schröter 1876	Apiaceae; Araliaceae; Plantaginaceae; Primulaceae: polyphagous; Cyperaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces lycoctoni*	Fuckel 1870	Ranunculaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces minor*	Schröter 1887	Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces muscari*	Léveillé 1847	Asparagaceae, narrowly oligophagous
	Pucciniales	Pucciniaceae	*Uromyces onobrychidis*	Léveillé 1847	Euphorbiaceae, narrowly monophagous; Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces pisi*	Liro 1908	Euphorbiaceae, narrowly monophagous; Fabaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces poae*	Rabenhorst 1866	Ranunculaceae, narrowly oligophagous; Poaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces polygoni-avicularis*	Otth 1864	Polygonaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces punctatus*	Schröter 1870	Euphorbiaceae, narrowly monophagous; Fabaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces rumicis*	Winter 1884	Ranunculaceae, narrowly monophagous; Polygonaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces scutellatus*	Léveillé 1847	Euphorbiaceae, monophagous

Fungi	Pucciniales	Pucciniaceae	*Uromyces striatus*	Schröter 1871	Euphorbiaceae, narrowly monophagous; Fabaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces striolatus*	Tranzschel 1910	Euphorbiaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces trifolii-repentis*	Liro 1906	Fabaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces valerianae*	Fuckel 1870	Caprifoliaceae, oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces verrucosae-craccae*	Mayor 1931	Euphorbiaceae, narrowly monophagous; Fabaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces verruculosus*	Berkeley & Broome 1871	Euphorbiaceae, narrowly monophagous; Caryophyllaceae, monophagous
Fungi	Pucciniales	Pucciniaceae	*Uromyces viciae-fabae*	Schröter 1875	Fabaceae, oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Hyalopsora aspidiotus*	Magnus 1901	Pinaceae, monophagous; Woodsiaceae, monophagous
Fungi	Pucciniales	Pucciniastraceae	*Hyalopsora polypodii*	Magnus 1901	Woodsiaceae, monophagous?
Fungi	Pucciniales	Pucciniastraceae	*Melampsorella caryophyllacearum*	Schröter 1874	Pinaceae, monophagous; Caryophyllaceae, oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Melampsorella symphyti*	Bubák 1903	Pinaceae, monophagous; Boraginaceae, oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Melampsoridium betulinum*	Klebahn 1899	Pinaceae, monophagous; Betulaceae, oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Melampsoridium carpini*	Dietel 1900	Betulaceae, oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Milesina blechni*	Arthur 1910	Blechnaceae, monophagous
Fungi	Pucciniales	Pucciniastraceae	*Milesina murariae*	Sydow & Sydow 1932	Aspleniaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniastraceae	*Milesina scolopendrii*	Henderson 1961	Aspleniaceae, narrowly monophagous
Fungi	Pucciniales	Pucciniastraceae	*Naohidemyces vacciniorum*	Spooner 1999	Pinaceae, monophagous; Ericaceae, monophagous
Fungi	Pucciniales	Pucciniastraceae	*Pucciniastrum agrimoniae*	Tranzschel 1895	Rosaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Pucciniastrum circaeae*	Spegazzini 1888	Pinaceae, monophagous; Onagraceae, monophagous
Fungi	Pucciniales	Pucciniastraceae	*Pucciniastrum epilobii*	Otth 1861	Pinaceae, monophagous; Onagraceae, broadly oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Pucciniastrum pyrolae*	Dietel 1907	Ericaceae, narrowly oligophagous
Fungi	Pucciniales	Pucciniastraceae	*Uredinopsis filicina*	Magnus 1893	Pinaceae, monophagous; Thelypteridaceae, monophagous
Fungi	Pucciniales	Raveneliaceae	*Nyssopsora echinata*	Arthur 1906	Apiaceae, oligophagous
Fungi	Pucciniales	Raveneliaceae	*Triphragmium ulmariae*	Link 1825	Rosaceae, narrowly monophagous
Fungi	Pucciniales	Uropyxidaceae	*Ochropsora ariae*	Ramsbottom 1923	Ranunculaceae, monophagous; Rosaceae, oligophagous
Fungi	Pucciniales	Uropyxidaceae	*Tranzschelia anemones*	Nannfeldt 1939	Ranunculaceae, narrowly oligophagous
Fungi	Pucciniales	Uropyxidaceae	*Tranzschelia discolor*	Tranzschel & Litvinov 1939	Ranunculaceae, narrowly monophagous; Rosaceae, monophagous

Fungi	Pucciniales	Uropyxidaceae	*Tranzschelia pruni-spinosae*	Dietel 1922	Ranunculaceae, narrowly monophagous; Rosaceae, monophagous
Fungi	Taphrinales	Taphrinaceae	*Protomyces macrosporus*	Unger 1834	Apiaceae, oligophagous
Fungi	Taphrinales		*Protomyces pachydermus*	Thümen 1874	Asteraceae, monophagous
*Fungi	Taphrinales	Taphrinaceae	*Taphrina alni*	Gjaerum 1966	Betulaceae, monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina betulina*	Rostrup 1883	Rosaceae, monophagous
*Fungi	Taphrinales	Taphrinaceae	*Taphrina crataegi*	Sadebeck 1890	Rosaceae, monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina deformans*	Tulasne 1866	Rosaceae, narrowly oligophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina insititiae*	Johanson 1886	Rosaceae, narrowly monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina johansonii*	Sadebeck 1890	Salicaceae, narrowly monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina padi*	Mix 1947	Rosaceae, narrowly monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina populina*	Fries 1832	Salicaceae, monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina pruni*	Tulasne 1866	Betulaceae, (narrowly?) monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina sadebeckii*	Johanson 1886	Betulaceae, monophagous
Fungi	Taphrinales	Taphrinaceae	*Taphrina tosquinetii*	Tulasne 1866	Rosaceae, monophagous
*Fungi	Taphrinales	Taphrinaceae	*Taphrina wiesneri (= T. cerasi)*	Mix 1954	Rosaceae, narrowly oligophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea arenariae*	Nannfeldt 1977	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea caricis*	Brefeld 1896	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea caricis-albae*	Kukkonen 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea caryophylleae*	Kukkonen 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea echinospora*	Kukkonen 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea heterospora*	Kukkonen 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea irregularis*	Boidol & Poelt 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea paniceae*	Kukkonen 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea pratensis*	Boidol & Poelt 1963	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Anthracoidea subinclusa*	Brefeld 1895	Cyperaceae, monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Farysia thuemenii*	Nannfeldt 1959	Cyperaceae, narrowly monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Moesziomyces bullatus*	Vánky 1977	Poaceae, oligophagous
Fungi	Ustilaginales	Anthracoideaceae	*Schizonella cocconii*	Liro 1938	Cyperaceae, monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Schizonella melanogramma*	Schröter 1877	Cyperaceae, monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Stegocintractia luzulae*	Piepenbring, Begorow & Oberwinkler 1999	Juncaceae, monophagous
Fungi	Ustilaginales	Anthracoideaceae	*Tolyposporium junci*	Woronin 1882	Juncaceae, narrowly monophagous
Fungi	Ustilaginales	Melanotaeniaceae	*Melanotaenium endogenum*	de Bary 1874	Rubiaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Macalpinomyces neglectus*	Vánky 2004	Poaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Mycosarcoma maydis (Ustilago m.)*	Brefeld 1912	Poaceae, narrowly oligophagous

Fungi	Ustilaginales	Ustilaginaceae	*Sporisorium andropogonis*	Vánky 1985	Poaceae, narrowly oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Sporisorium destruens*	Vánky 1985	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Tranzscheliella hypodytes*	Vánky & McKenzie 2002	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago avenae*	Rostrup 1890	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago bullata*	Berkeley 1855	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago calamagrostidis*	Clinton 1902	Poaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago davisii*	Liro 1924	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago filiformis*	Rostrup 1890	Poaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago hordei*	Lagerheim 1899	Poaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago nuda*	Rostrup 1889	Poaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago perrara*	Scholz & Scholz 1988	Poaceae, monophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago serpens*	Lindeberg 1959	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago striiformis*	Niessl 1876	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago syntherismae*	Peck 1875	Poaceae, oligophagous
Fungi	Ustilaginales	Ustilaginaceae	*Ustilago tritici*	Rostrup 1890	Poaceae, oligophagous
Plantae	Convolvulaceae	Convolvulaceae	*Cuscuta europaea*	Linee	
Plantae	Santalaes	Viscaceae	*Viscum album spp. abies & album*	Linee	woody dicotyledons