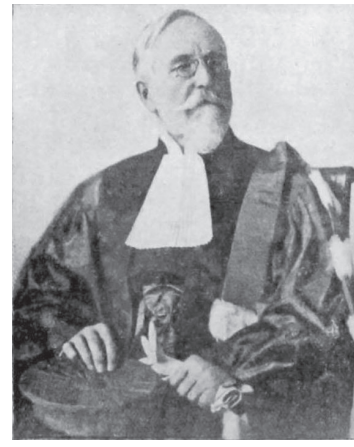
CONTENTS

Herbert Buhr
1902–1968

Herbert Buhr was born in Teterow, Germany. He studied chemistry, botany, zoology in Darmstadt and was trained, later on, in botany, zoology and pharmacy at the University of Rostock, Germany. As an assistant at the Botanical Institute of the Rostock University he made excursions to Dalmatia and Corsica. His thesis was on "Studies on Bispored Hymenomycetae" (1932) and his postdoctoral lecture qualification was on "Effects of Parasites and Relationship" (1935). As lecturer in botany and pharmacy at the University of Rostock (1936–1941) he did phytopathological research in Cameroun. After World War II, Buhr was a scientific fellow during 1949–1954 and, later on, leader of the Department of Analytical Biochemistry at the Institute of Plant Breeding of the German Academy of Agricultural Sciences at Groß-Lüsewitz (Mecklenburg-Vorpommern). From 1954 onwards, until his retirement in 1961, he was leader of the Scientific Institute of the German Academy of Agricultural Sciences at Mühlhausen (Thuringia). Buhr died in Mühlhausen in 1968.

Beside his professional activities Buhr worked indefatigably on his special fields: plant galls and leaf mines. His teachers and scientific friends were the professors of zoology Paul Schulze (1887–1949), Egon Schlottke (1901–1944), and Erich Martin Hering (1893–1967). Observation and collection of plant galls and leaf mines, rearing of the causers and their determination by specialists, resulted in an extensive herbarium of plant galls and leaf mines. This collection was donated to the Herbarium Haussknecht, Institute of Special Botany, at the University of Jena. Buhr published, (mainly as sole author) more than than 50 papers on plant galls and leafminers. This impressive list culminated in his main work: Identifications keys of galls (Zoo- and Phytocecidia) on plants of Central- and North Europa, 2 vols, 1572 pp. + 443 figs., Jena (1964/65), which is the basis for the present revision. (Photo courtesy of H.-J. Buhr)

Clodomir Houard 1873–1943



Clodomir Antony Vincent Houard was born in Sainte-Colombe-sur- Loing (Yonne, France). His main teachers were the entomologist L.-E. Bouvier, and the botanist G. Bonnier at Sorbonne University, Paris. Houard devoted his entire scientific life to the relations between plants and animal gall inducers. His thesis was on "Anatomical Research of Galls in Twigs (Pleurocecidia)", Paris (1903). Houard had an impressive scientific career: Professor in Botany at the University of Caen (1916), Professor of Botany and Director of the Botanical Garden at the University of Strasbourg (1919). He was rewarded with many prizes, among which was the Grand Prix of Physical Sciences (1933). The study of galls of Europe resulted in his monumental work: Zoocecidia of plants of Europe and the Mediterranean Basin, 3 vols, 1560 pp. + 1566 figs, Paris (1908–1913). Later on he extended his studies to zoocecidia of North Africa, West and Equatorial Africa, and eventually to Asia and the Americas and published these in seven volumes. Unfortunately, the manuscript of the eighth volume (Plant galls of America, oak galls excepted), was lost during World War II. Apart from these major publications, he published about 70 papers on zoocecidia. His collection of galls was donated to the National Museum of Natural History (Paris). Houard died in Coulanges-sur-Yonne (Yonne). (Chevalier, 1944, photo courtesy of NBC–Naturalis).

Introduction

In 1964 and 1965 the two volumes of Herbert Buhr's 'Bestimmungstabellen der Gallen (Zoo- und Phytocecidien) an Pflanzen Mittel- und Nordeuropas' were published. These keys were developed in the great tradition of cecidology intiated by cecidologists such as Rübsaamen, Ross, Hedicke, in Germany, Barnes, Connold, Bagnall & Harrison and Swanton in Great Britain, and Kieffer and Houard in France. During the second half of the twentieth century a new generation of cecidologists expanded significantly our knowledge of plant galls and their distribution. New gall books were published for several countries, e. g., Coulianos & Holmåsen (1991) for Sweden, Csóka (1991) for Hungary, Dauphin & Aniotsbehère (1997) for France, Redfern et al. (2002, 2011) for Great Britain, or have been revised, e. g., Docters van Leeuwen (2009) for The Netherlands. In an era in which urbanization, habitats and climates, and biodiversity in general, have changed dramatically, we felt a need to collect this new knowledge and incorporate it into a revision of Herbert Buhr's monumental work in order to make it accessible for future generations of students of plant galls. This is because plant galls remain the most fascinating, though still largely unknown, associations produced by biological evolution.

To make Buhr's keys, and additions taken from Houard (1908/1913) accessible to many students, we decided to translate them into English. We abandoned, however, Buhr's General Part, as its content is now substantially covered and extended by recent books such as Raman et al. (2005), Redfern (2011), and for rust fungi Termorshuizen & Swertz (2011). The generic and specific nomenclature of gall inducers was updated, using internet databases such as www.indexfungorum.org, supported by CAB International (CABI), Bioscience and Landcare Research, and the Fauna Europaea project, www.faunaeur.org, funded by the European Commission. Host plant names have been updated according to www.theplantlist.org, which is also followed for the assignment of host plant genera. Information about specific groups of gall inducers has been reviewed and revised by a team of specialists, as listed above. They seized the opportunity to revise the detail of the keys. We decided that for new additions (NM.) we will not continue Buhr's numbering of galls; we have retained his original numbering for the galls that he included in his edition.

Herbert Buhr had a broad concept of a gall and included many malformations which may not be considered to be real galls. Nevertheless we retained these malformations in the keys, for the sake of completeness. We follow the definition of galls as given by Redfern & Shirley (2011): 'A gall is an abnormal growth produced by a plant under the influence of another organism. It involves enlargement and/or proliferation of the host's cells or vascular tissue, and provides both protection and nutrition for the gall causer'.

Host-parasite associations

In order to detect phylogenetic radiations of gall inducers on host plants, associations between these parasites and their hosts are discussed because such an analysis is absent from plant gall textbooks. Patterns are analysed for major groups of plants, such as algae, fungi, mosses, ferns, and gymnosperms. Also, within the monocots, the major groups Corolliferae, Juncaceae, Cyperaceae and Poaceae are discussed separately. Within dicots, associations have been treated at host family level; the families are arranged in alphabetical order.

Host-parasite associations of generalist gallers

Most gall causers are more or less specialists in their host associations: they develop on only a few host species which all belong to the same genus or to a few related genera. Some gallers develop on many species of a host plant family; examples may be found in Brassicaceae and Apiaceae and will be treated in the respective host plant family sections below. The really polyphagous gallers, which cross the family boundaries in their host plant choice, are discussed here; they may be found among both plant and animal gallers.

Crown gall bacterium, *Agrobacterium tumefaciens* is a real generalist on dicotyledonous hosts. Globular proliferations, with compact rough surface, are induced on more than fifty hosts, including herbs as well as shrubs and trees. Artichoke-like 'leafy'galls on root collars are caused by another bacterium, *Rhodococcus fascians*. This bacterium, with more than 20 recorded host associations, usually occurs on herbaceous and shrubby dicotyledons; and it has also been recorded from grasses, *Triticum* (Poaceae)*, Lilium* (Liliaceae), and *Gladiolus* (Iridaceae). Root nodule bacterium, *Rhizobium leguminosarum* causes elongate-cylindrical or also fork-shaped to coralloid branched nodules on roots. It occurs, together with a few more fastidious rhizobiums, exclusively on Fabaceae.

Among chytrids *Physoderma pulposum* (on Apiaceae and Chenopodiaceae) and *P. vagans* (on more than ten representatives of six dicotyledonous families) cause small warts and bulges. *Synchytrium aureum* (with more than seventy records) and *S. globosum* (about ten records) cause small warts mainly on lower stem parts. *Plasmodiophora brassicae* causes swellings in main roots and stems of almost all Brassicaceae. The 'wart disease' or 'potato cancer' *Synchytrium endobioticum* is restricted to Solanaceae. Ergot, *Claviceps*

purpurea, a sac fungus and not a true galler, must be mentioned for grasses and cereals. Among rust fungi, several species of *Gymnosporangium* alternate between gymnosperms and Rosaceae and several species of *Melampsorella* alternate between gymnosperms and representatives of several angiosperm families. The same holds for *Puccinia*. *P. arenariae*, for example, alternates between sedges and many Caryophyllaceae. White blister *Albugo candida* is known from almost all Brassicaceae; *A. tragopogonis* from many *Asteraceae*.The sac fungus *Neonectria ditissima* has been recorded on many trees, irrespective of their family assignment, and the same holds for mistleoe, *Viscum album.*

Among eelworms, several species of *Anguina* occur exclusively on Poaceae, as does oat eelworm, *Heterodera avenae*. *H. cruciferae*, however, is restricted to Brassicaceae, *H. goettingiana* and *H. trifolii* to Fabaceae, *H. rostochiensis* to Solanaceae. The cyst eelworm *H. schachtii* is a really polyphagous eelworm, it occurs on hosts assigned to at least eight different dicotyledonous families. The strawberry eelworm *Aphelenchoides fragariae* attacks, strawberries and representatives of five different dicotyledonous families. Root knot eelworms, *Meloidogyne*, have been recorded on almost all dicots, some monocots and even on juniper. Many *Meloidogyne* galls have not been identified and belong to several species; galls bearing adventitious roots are induced by *M. hapla*, known from many dicots. Grass root gall eelworms *Subanguina radicicola* and *S. graminophila* have been recorded from many grasses. Two other *Subanguina* species are known from *Primula* and *Achillea*. Among gall mites most species have narrow host ranges, but some attack many representatives of the same host family. For example, *Aceria cornuta* and *A. tenuis* occur on many grasses, *A. drabae* on many crucifers, *A. peucedani* on many umbellifers.

Aphids usually alternate between primary – often woody –, and secondary – often herbaceous – hosts. For example, *Pemphigus populinigrae* alternates between *Populus* and two related composite genera, *Filago* and *Gnaphalium*. So this aphid should be regarded as oligophagous, although it disfigures unrelated host species. Nevertheless a number of aphids are common on many unrelated host species. Examples are black bean aphid, *Aphis fabae, frangulae, gossypii* and *Aulacorthum solani*. *Rhopalosiphum padi* alternates between *Prunus* and at least twelve grass genera, maize included, but *R. nymphae* infests many taxonomically distantly-related aquatic plants such as the dicots *Nymphaea, Nuphar, Potamogeton, Hippuris* and the monocot *Sagittaria*. Finally, *Acyrtosiphon malvae* has been recorded on Malvaceae, Geraniaceae and Acanthaceae.

Among gall wasps really polyphagous representatives are absent; most are specialised on oaks. *Aulacidea hieracii* occurs on Asteraceae, as well as other *Aulacidea* species. *Aylax* species occur on Papaveraceae, excepted *A. onobrychidis* on Fabaceae.

Also among gall midges really polyphagous species are absent, at least in Europe. *Contarinia nasturtii* is common on many Brassicaceae, as well as *Dasineura napi, D. sisymbrii* and *Gephyraulus raphanistri*. *Haplodiplosis marginata, Hybolasioptera fasciata, Lasioptera calamagrostidis* and all *Mayetiola* species are restricted to grasses. *Rabdophaga* is in Europe restricted to willows, *Rhopalomyia* to Asteraceae; *Lasioptera carophila, Kiefferia pericarpiicola* and *Macrolabis heraclei* to umbellifers.

Host-parasite associations of specialist gallers

Algae

Gall inducers on algae usually belong either to the lower fungi, Oomycota and Chytridiomycota, or to other algae, often belonging to the same phylum. Animal gall inducers on algae are less common; they are copepods or eelworms. The rotifer *Proales werneckii* is a well-known galler on many *Vaucheria* species, causing peculiar club- or sac-shaped lateral protrusions of the filaments which are provided with corniculate appendages. The inducer, or its eggs, is situated inside the tube.

The chytrid *Rhizosiphon* causes swollen filaments on the cyanobacterium *Anabaena* and a number of gallers are reported from red algae. Unidentified bacteria have been thought to cause swollen thallus branches on several Batrachospermales; the green alga *Spongomorpha* causes pustular galls on *Dilsea* (Gigartinales). The Oomycota *Pontisma* and *Eurychasmidium* cause enlarged cells on their red algae hosts *Asparagopsis* and *Ceramium*, respectively. Associations in which both symbionts are red algae are reported for *Callophyllis* (galler: *Callocolax*), *Gracillaria* (with *Holmsella*), *Polysiphonia* (with *Choreocolax*) and *Rhodomela* (with *Harveyella*).

The water mould *Anisolpidium sphacelarum* has been recorded from the brown algae *Cladostephus* and *Sphacelaria*; the water mould *Eurychasma dicksonii* causes distortions on at least four brown algae: *Ectocarpus, Hincksia, Pylaiella* and *Striara*. Four species of the chytrid genus *Micromyces* occur on the green alga *Mougeotia* of which *Micromyces zygogonii* is also reported from the green algae *Netrium, Spirogyra* and *Zygogonium*. Another chytrid, *Plasmophagus,* occurs on three genera of green algae, with *P. oedogonii* also on *Oedogonium* as well as on *Tribonema*. The chytrid *Pleocystidium parasiticum* disfigures resting spores of *Mougeotia* and *Spirogyra*. Finally, species of the water mould *Woronina* have been reported from the yellow-green alga *Vaucheria* and the green alga *Mougeotia*.

Unidentified eelworms occur on *Chondrus* and *Furcellaria*, but these might be inquilines in galls of other, unknown, inducers. Eelworms belonging to *Halenchus* cause swellings on the brown algae *Ascophyllum* and *Fucus*. The copepods *Thalestris* and *Harpacticus* are common causers of papillate swellings on the thalli of *Palmaria* and *Rhodymenia*, respectively.

Fungi

Gall inducing fungi occur on lower fungi, viz., Oomycota, Chytridiomycota and Zygomycota, as well as on higher fungi, such as Ascomycota and Basidiomycota. Animal gallers are only known from higher fungi and are often unidentified, but all belong to the Diptera. Oomycota hosts are all parasitised by other Oomycota: *Olpidiopsis* – with six species on *Saprolegnia –; Rozella, Rozellopsis* and *Woronina* frequently cause swollen septate hyphae on host

mycelia. *Rozella* is also known from the chytrid host *Allomyces* and Mucoraceae are infested by other Mucoraceae, such as *Chaetocladium* and *Parasitella*.

The sac fungus *Opegrapha* is parasitised by another sac fungus, *Licenoconium,* causing disfigured apothecia. The sac fungus *Hypomyces* is also reported from Agaricaceae, as well as causing distorted gills, as on Polyporaceae. Also the sac fungi *Calcarisporium* and *Lecanicillium* infest Agaricaceae. *Syzygospora* [= *Christiansenia*], Aphyllophorales, is the only basidiomycete galler infesting fellow Basidiomycetes.

The gall midge *Mycocecis* causes galls on fruiting bodies of *Hypoxylon* (Ascomycota). Other Cecidomyiidae, plus Drosophilidae, Mycetophilidae and Phoridae, cause galls on fruiting bodies, often distorting gills of Basidiomycota. *Agathomyia*, Platypezidae, causes conspicuous 'teat'-galls on *Ganoderma*.

Lichens

Many swellings are caused by ascomycete parasites, such as *Abrothallus, Didymellopsis, Lichenoconium* and *Phacopsis*. Basidiomycota – Tremellaceae cause malformations on *Caloplaca*, *Cetraria* and *Usnea.* The blue alga *Nostoc* has been reported to cause swellings on *Lobaria, Peltigera and Solorina.* Globular proliferations caused by animal inducers, in a number of cases unidentified mites, have been reported from *Parmelia, Pertusaria* and *Ramalina.*

Mosses and liverworts

Gallers are unknown on thallose liverworts. Tips of shoots of mosses as well as leafy liverworts are frequently disfigured by unidentified *Ditylenchus* eelworms. Occasionally two other eelworm species have been recorded, viz., (1) *Subanguina askenasyi* on *Aulacomnium, Hypnum, Pleurozium, Racomitrium, Thuidium, Tortula* and the leafy liverwort *Cephaloziella*, and (2) *Tylenchus davainei* on *Oxyrrhynchium* and on the leafy liverwort *Harpanthus.* Both cause both stunted shoots and clustered leaves.

Gall inducing fungi are absent from liverworts, but are often present on mosses. The oomycetes *Pleotrachelus wildemanii* and *Syzygangia elliptica* develop sporangia in swollen rhizoidsof *Funaria*, and *Synchytrium muscicola* develops one-celled globular leaf galls on *Anomodon, Leucodon, Neckera* and *Warnstorfia*. Finally, three species of the sac fungus *Octospora* with apparent strict host specificity, viz., *O. wrightii, rubens* and *humosa,* develop swellings of rhizoids and apothecia on leaves of *Amblystegium, Ceratodon* and *Pogonatum,* respectively. Finally, spores of the sac fungus *Helotium schimperi* occur in the capsules of many *Sphagnum* species.

Ferns

Wart-like galls of the chytrids *Synchytrium athyrii* and *phegopteridis* occur on leaflets of *Athyrium* and *Phegopteris,* respectively, and asci of the sac fungus *Taphrina athyrii, filicina* and *wettsteiniana* may develop on the underside of leaves of *Athyrium, Dryopteris* and *Polystichum,* respectively.

Most animal gallers have been recorded for *Pteridium*, viz., the gall mite *Eriophyes pteridis*, the moth *Monochroa cytisella* and two gall midges, *Dasineura pteridis* and *D. pteridicola*. The anthomyiid fly *Chirosia betuleti* causes tufts of distorted fronds on *Pteridium*, as well as on *Athyrium* and *Thelypteris*.

Gymnosperms

Like many angiosperm trees, gymnosperms are occasionally disfigured by mistletoes, *Viscum album* subspp. *abietis* and *austriacum* (angiosperms, Loranthaceae). Records are known for *Abies, Larix, Picea* and *Pinus*.

Juniperus is the primary host for *Gymnosporangium* rust fungi. Two other rusts belong to *Chrysomyxa* on *Picea*; furthermore *Coleosporium tussilaginis, Cronartium flaccidum ribicola* and *Endocronartium pini* (all on *Pinus*); *Melampsorella caryophyllacearum* on *Abies* and *M. populnea* on *Pinus*; *Pucciniastrum areolatum* on *Picea. Lepidoderma carestianum* is a smut fungus known from *Juniperus* and *Exobasidium myrtilli* is a smut on *Chamaecyparis*. Finally, three gall inducing ascomycetes are known from gymnosperms: *Ceratostoma juniperinum* on *Juniperus*, and *Cucurbitaria piceae* and the bark cancer *Neonectria fuckeliana* on *Picea*.

So-called pineapple or pseudocone galls are well-known on conifers, and are caused by a large number of woolly aphids: *Adelges* on *Pinus, Picea, Larix* and *Taxus*, with *A. laricis* occurring on both *Larix* and *Picea*; *Dreyfusia* on *Abies* and *Picea* with *D. merkeri, nordmannianae* and *prelli* on *Abies* as well as on *Picea*. *Sacciphanthes* is known from *Picea* and *Larix* with *S. viridis* occurring on both host genera. *Pineus*, with three species, is recorded from *Picea* and *Pinus* and, finally, *Aphrastania* occurs with two species on *Picea.* Gall midges are well represented on Gymnospermae: *Dasineura abietiperda* and *kellneri* on *Picea* and *Larix*, respectively; *Kaltenbachiola strobi* on *Picea* and *Pinus* and at least five *Oligotrophus* species radiated on *Juniperus*. Finally, *Xerephedromyia ustjurtensi*, described from Kazakhstan on *Ephedra*, is also recorded from the Mediterranean. Nine *Tricetacus* gall mite species are known from *Abies, Pinus, Larix, Thuja* and *Juniperus*, with *T. pini* occurring on *Abies* as well as on *Pinus*. The leafroller *Cydia* is represented by five species on *Pinus, Picea, Larix* and *Juniperus* with *C. duplicana* on both *Picea* and *Juniperus*.

Monocotyledoneae

Corolliferae

Corolliferae are hosts for many parasitic bacteria, slime moulds and fungi. The polyphagous bacterium *Rhodococcus fascians* causes subterranean 'leafy bud galls' on *Gladiolus* and *Lilium* and the slime moulds *Plasmodiophora* and *Tetramyxa* have been reported from *Ruppia, Triglochin* and *Zanichellia* in salt marsh habitats. The water mould *Physoderma maculare* causes bulges on leaves and stems of *Alisma* and *Baldellia*, both Alismataceae, and *Physoderma allii* causes similar malformations on inflorescences of *Allium*. Several oligophagous species of the chytrid *Synchytrium* cause one-celled warts on

1b Disfigured leaflets. *A. nilotica* [= *Mimosa nilotica vera*].

(Dipt.) Cecidomyiidae – ***Dasineura mimosae*** (Kieffer)
H. 3327. Egypt; Frauenfeld, 1855a; Bergenstamm & P. Löw, 1876.

Acanthus – Acanthaceae

1a Leaf margin curled. *A. mollis.*

(Hem.) – Unidentified *scale insect*
H. 5140. Madeira; Tavares, 1905abc.

Acarospora – Lichenes: Acarosporaceae

1a Facultatively gall inducing on several *Cladonia* species, also on this lichen. *A. nodulosa.*

(Ascom.) Heliotiales – ***Phaeopyxis punctum*** (A. Massalongo) Rambold, Triebel & Coppins [= *Nesolechia cladoniaria* (Nylander) Arnold]
HB. 10; WNE. Eu (CH, GB, IRL), rare. Von Keissler, 1930; Grummann, 1960; Rambold & Triebel, 1990; Spooner, 2008.

Acer – Sapindaceae

1a On above-ground parts → 2
1b Roots with rotund, single-chambered brownish galls, up to 9 mm across, often gregarious and similarly ± flattened later on and partially coalesced. Wall initially succulent, lignified later on. Each contains a single larva. [G]. *A. pseudoplatanus*. Pl. 1, fig. 2.

(Hym.) Cynipidae – ***Pediaspis aceris*** (Gmelin) ♀♀
HB. 11; RH. 5; H. 3969; DA. p222; DvL. p74; WNE. Widely distributed in Eu. Galls mature in 9; adults in spring, usually of the third year; galls of the sexual generation on various above-ground parts (HB. 19, 25, 27, 73). Mayr, 1876; Lichtenstein-Adler, 1881; Kieffer, 1897–1901, 1898a; Pigeot, 1902; Scheidter, 1928; Ross, 1932; Nieves-Aldrey, 2001; Lambinon et al., 2003, 2015; Tomasi, 2003, 2014; Melika, 2006; Abras et al., 2008; Hellrigl, 2008; Pellizzari, 2010; Groom, 2011; Béguinot, 2002eh, 2003a, 2005, 2006c, 2012; Bellmann, 2012; Kwast, 2012. – Bronner (1981) described parasitic malformations of the gall; Pujade (1994) studied the parasitoids.
1c Galls smaller, massive. *A. negundo*.

(Nem.) Meloidogynidae, Root knot eelworm – ***Meloidogyne*** sp.
HB. 12. Euro-Siberia, Ustinow (1939). Goodey et al., 1956, 1959; Bongers, 1988.
2a Malformations of flowering or fruiting, inflorescences and their parts → 48
2b Malformations of buds, axial parts or leaves → 3
3a On leaves → 13
3b On buds or axial parts → 4
4a Galls on shoots → 6
4b Malformations of buds → 5
5a Buds swollen. *A. pseudoplatanus*.

(Acar.) Eriophyoidea – ***Aceria vermicularis*** (Nalepa)

HB. 13; RH. 10; H. 4002; DA. p222; RS. p20; WNE. Galls reported from C-Eu (A, BIH, CZ, H, HR) but recently B, GB, L, and probably F. Nalepa, 1902ab; von Schlechtendal, 1916; Krott, 1952; Farkas, 1965a; Béguinot, 2006c; Schneider, 2016.

– Baudyš (1954a) reported similar galls on *A. saccharinum* from C-Eu and attributed these, with reservation, to this species (NM. 7).

5b Buds atrophied, widely opened. Inside a crumbly mass. *A. pseudoplatanus*.

Inducer unknown

HB. 14; RH. 11, H. 7037. E. Möhn, in litt. to HB., analysed malformations which were collected by Dittrich in Silesia and supposed a gall mite (also *A. vermicularis*? S. Carbonnelle, in litt. to JCR. – Comp. RS. p20), and not, as stated in literature, a gall midge as inducer.

6a (4) Witches' broom-like malformations or galls caused by mistletoes → 12

6b More or less distinctly protruding swellings or proliferations on axial parts → 7

7a Malformations mainly on the younger twigs → 8

7b Bark with ± expanded open wounds, with irregularly bulging callus proliferations at their margins. '*Nectria*-cancer'. ~

(Ascom.) Nectriaceae – ***Neonectria ditissima*** (Tulasne & C. Tulasne) Samuels & Rossman [= *N. galligena* (Bresadola) Rossman & Samuels; asexual morph *Cylindrocarpon heteronema* (Berkeley & Broome) Wollenweber]

HB. 15; WNE. Ascomata forming superficially on well-developed stroma, aggregating in groups up to 30, rarely solitary, 250–400 µm diameter. Asci 88–116 x 12–17 µm; ascospores 14.9–18.9 x 6.5–8.3 µm. Not a true gall causer. Eu, N-Am. Viennot-Bourgin (1949) reported for maple *N. coccinea* var. *longiconia* Woronin and var. *minor* Woronin, fungi which are, according to Richter, not pathogenic. Moritz, 1930; Castlebury et al., 2006; Rossman et al., 2013.

– On various occasions so-called 'burrs' have been recorded on the bark of older maple stems, which originate from a distinctly narrowed base, often rotund-oval, and up to 2.5 x 3.5 cm, sometimes also substantially larger. These structures, usually lacking pith, are not true galls, but develop as a response to biotic or abiotic factors. Van der Lek, 1929; Böhner, 1935.

7c Similar gall-like proliferations have been described from N-Am and are attributed to either

(Bact.) Rhizobiaceae, Crown gall bacterium – ***Agrobacterium tumefaciens*** (Smith & Townsend) Conn

And/ or

(Ascom.) Diaporthaceae – ***Phomopsis*** sp.

HB. 16; WNE. Brown, 1941; Elliot, 1951; Tomasi, 2003, 2012, 2014; Hellrigl, 2010; Melgarejo Nárdiz et al., 2010; Bellmann, 2012; Salas-Remón et al., 2015.

8a Inducers inside the galls → 9

8b Bark of younger as well as older side branches with flat, irregularly pock-like swellings. Causer in shallow, rimmed depression. Heavily infected parts additionally thickened and ± stunted. ~

(Hem.) Diaspididae, Willow scale – ***Chionaspis salicis*** (Linnaeus)

HB. 17; WNE. Euro-Siberia, etc. On many woody hosts, univoltine in Eu. Schmutterer et al., 1957; Schmutterer & Hoffmann, 2003; Hellrigl, 2004a, 2006; Malumphy et al., 2008; Malumphy & Ostrauskas, 2009; Malumphy, 2010; Tomasi, 2012, 2014.

9a Galls on bark → 10

9b First- or second-year twigs swollen on all sides below a node. The pith contains a caterpillar; grey-yellow to brownish with dark- to black-brown head. [S]. *A. campestre, platanoides.*

(Lep.) Tortricidae, Poplar shoot borer – ***Gypsonoma aceriana*** (Duponchel)

HB. 18; RH. 9; H. 4047; DA. p222. Eu; more abundant on poplars. The caterpillar bores into the petiole and midrib, migrates to the shoot in 8, in the following year bores into a young shoot which it eventually deserts for pupation. Moths 6, 7. Kieffer, 1901a; Henriksen & Tuxen (1944) mentioned such galls from *A. saccharinum* [= *dasycarpum*]. – The reference to *Acer* is incorrect, see WNE.

10a Galls irregular, up to 2 mm high and 3.5 mm across, tubular-wart-shaped, often on base of one-year twigs. Solitary or gregarious, variously coalesced in the latter case → 11

10b Globular, up to 8 mm across, single-chambered galls on the bark of young twigs. *A. pseudoplatanus.*

(Hym.) Cynipidae – ***Pediaspis aceris*** (Gmelin) ♀♂ [= *P. sorbi*]

HB. 19; RH. 6; H. 3970; WNE. Widely distributed in Eu. Galls mainly on leaves (HB. 27). References, see HB. 11.

11a On *A. platanoides*.

(Acar.) Eriophyoidea – ***Aceria heteronyx*** (Nalepa) [= *Eriophyes heteronyx*]

HB. 20; RH. 8; H. 3990, 4012; DA. p222; RS. p19; NB. 3; WNE. Scattered distribution in Eu. Von Schlechtendal, 1882a, 1916; Liebel, 1886; Massalongo, 1891a; Kieffer, 1892b; Nalepa, 1898a; Trotter & Cecconi, 1907; Krott, 1952; Farkas, 1965a; Ripka & de Lillo, 1997; Tomasi, 2003; Ripka, 2007; Kollár, 2011; Spooner, 2014a; Lambinon et al., 2015; Carbonnelle & Romain, 2016.

11b On *A. campestre*.

(Acar.) Eriophyoidea – ***Aceria aceriscampestris*** (Nalepa) [= *Eriophyes aceriscampestris*]

HB. 21; RH. 7; H. 4012; DA. p222; DvL. p73; WNE. Scattered distribution in Eu, rather rare. Von Schlechtendal, 1916; Weidner, 1954; Ripka & de Lillo, 1997; O'Connor, 2003; Ripka, 2007; Béguinot, 2002adefh, 2003a, 2005, 2006c, 2007b, 2012; Lehmann & Flügel, 2012; Lambinon et al., 2015.

Note: taxonomy of *A. heteronyx, aceriscampestris* and *A. myriadeum* is confused. We restrict *A. hereronyx* and *A. aceriscampestris* for bark galls on *Acer platanoides* and *campestre*, respectively, and *A. myriadeum* for leaf galls on *Acer campestre* (S. Carbonnelle, in litt. to JCR).

– Ripka (2007) recorded from H on *A. tataricum* the eriophyoid mite *Shevtchenkella tataricis* (Farkas) [= *Oxypleurites tataricis*] vagrant on leaves. Farkas, 1965a; Ripka & de Lillo, 1997.

Warnstorfia – Musci: Amblystegiaceae

(see also *Drepanocladus*)

1a Rotund to pear-shaped, galls on leaves, 50–100 µm long, single-celled ± coalescing on the veins. Containing a single sorus. *W. fluitans* [= *Drepanocladus fluitans*].

(Chytridiom.) Synchytriaceae – ***Synchytrium muscicola*** Reinsch
HB. 2409. Recorded on this host from D, Fichtel Mountains, also known from other mosses. Tobler, 1913; Karling, 1964; Brandenburger, 1985; Jage et al., 2010; Klenke & Scholler, 2015.

1b Leaves on the stunted shoot tip disfigured, broadened, clustered into a rotund or oblong tuft. *W. fluitans* [= *Drepanocladus fluitans*].

(Nem.) Eelworm – ***Ditylenchus*** sp.
HB. 2410; RH. 905; H. 50–53. Sanio, 1887; Mönckemeyer, 1902; Warnstorf, 1903; Matouschek, 1904; Schiffner, 1906; Ross, 1922; Goodey & Franklin, 1956.

Washingtonia – Arecaceae [= Palmae]

(incl. *Pritchardia*)

1a Nodular swellings on roots. *W. filifera, robusta*.

(Nem.) Anguinidae, Grass root gall eelworm – ***Subanguina radicicola*** (Greeff) [= *Ditylenchus radicicola*]
H. 6334/34A. On cultivated palms in Botanical Garden Prague. Nemée, 1910.

Willemetia – Asteraceae

1a Leaf blade with abnormal pubescence on both sides. *W. stipitata* [= *apargioides, hieracioides*].

(Acar.) – Unidentified *gall mite*
HB. 7643; RH. 2990. Hairs long, cylindrical, thin-walled, rounded at top. Galls described from D (Bavaria); Ross, 1922.

1b Yellowish, hardly swollen, spermogonia- and aecia-bearing rotund to oblong-oval, pads on leaf blade and venation arched on the underside. *W. stipitata* [= *apargioides, hieracioides*].

(Basidiom.) Pucciniales – ***Puccinia willemetiae*** Bubák 0 I
HB. 7644; WNE. Galls facultative, inconspicuous. Aecia 5, 6. Fungus host-specific, rather rare in mountainous areas of S-Eu. Bubák, 1908; Gäumann, 1959; Mayor, 1970; Brandenburger, 1985; Schmid-Heckel, 1985; Jage et al., 2010.

Wulfenia – Plantaginaceae [ex Scrophulariaceae]

1a Midrib from infestation site deflected over the tip, adjacent leaf blade parts strongly curled, deep green; leaf margins bent downwards. *W. carinthiaca*.

(Hem.) Aphrophoridae, Spittlebug – ***Philaenus spumarius*** (Linnaeus)
HB. 7645. Infestation, 6–7 during several years; additionally also observed on *Wulfeniopsis amherstiana*; HB.

Xanthium – Asteraceae

1a Roots with nodule- to spindle-shaped swellings bear some lateral roots.

(Nem.) Meloidogynidae, Root knot eelworm – ***Meloidogyne hapla*** Chitwood

HB. 7646. Galls observed in D (Mecklenburg) on *X. strumarium* [= *riparium*]; HB. – *Meloidogyne* galls (HB. 7647) also recorded on *X. strumarium* from RUS and *X. spinosum* from TR. Goodey & Franklin, 1956; Bongers, 1988.

1b Rotund to oblong-oval bulges on leaves and stems, bearing brown telia.

(Basidiom.) Pucciniales – ***Puccinia xanthii*** Schweinitz III

HB. 7648; DA. p306; WNE. The sori sometimes develop inside the host tissue. Originally N-Am, invading into Eu. 7–9 (10); Eu (F, R, SP); Kuhnholtz-Lordat, 1942; Kuhnholtz-Lordat et al., 1951; Gäumann, 1959; Brandenburger, 1985; Negrean & Anastasiu, 2006; Termorshuizen & Swertz, 2011; Savchenko et al., 2014; Tomasi, 2014; Klenke & Scholler, 2015.

– The f. sp. *annui* Woronin of the rust fungus *Puccinia helianthi* Schweinitz, host-specific with many forms on *Helianthus* species, may occur on *X. strumarium* without inducing galls. See also DA p306; Termorshuizen & Swertz, 2011.

Xanthoparmelia see **Parmelia**

Xanthoria – Lichenes: Teloschistaceae

1a The malformations bear fungus fruiting bodies → 2

1b Thallus lobes with clustered aborted apothecia bearing many gall-like globular malformations, initially stalked, then sessile, at surface warty-rugose or ± plicate, about 0.9–3 mm high, thallus-coloured or pale yellow, always without apothecia. *X. aureola* (Acharius) Erichsen.

Pseudocecidia

Malformations reported by Grummann (1960) for D (Mecklenburg), regeneration tissue of damage by animal feeding.

2a The fruiting bodies belong to parasitic fungi on lichen hosts → 3

2b Patches with several densely positioned vividly coloured swellings up to almost 0.3 mm across, conical, or if more isolated, cauliflower-like, up to 1.1 x 0.85 mm, covered with crowded spermogonia of the host. *X. candelaria* (Linnaeus) Fries.

Pseudocecidia

Malformations described by Bachmann (1929b) for D (Brandenburg).

– Usually with several erupting, slight gall-like swellings on dirty-grey discoloured spots on thalli or fruiting discs, containing spermogonia. *Xanthoria parietina* (Linnaeus) Fries var. *parietina*. Not a parasite but another lichen *Opegrapha physciaria* (Nylander) D. Hawksworth & Coppins [= *Celidium varium* (Tulasne) Körber].

HB. 7648A. E.g., von Keissler, 1930.

3a Galls thick disc- to pancake-shaped, tuberculate, irregularly lobed to even stalked and club-like. Contain embedded small black fructifications, rarely up to 1 mm broad, rotund-flattened. *Xanthoria parietina* (Linnaeus) Fries.

(Ascom.) Dothideales – ***Perigrapha superveniens*** (Nylander) Hafellner

[= *Metasphaeria superveniens* (Nylander) Saccardo & D. Saccardo]

HB. 7649. Asci contain 4–8 hyaline spores, 4-celled, spindle-shaped, basally strongly narrowed 6–7 x 32–26 µm. Infected hosts usually remain sterile. Fungus and galls in C-Eu also recorded from *Parmelia* (HB. 4553). Bachmann (1929b) reported also a fungus, found in *Xanthoria* galls. Von Keissler, 1930; Grummann, 1960.

3b Fungus occasionally develops small galls. Infected sites on thallus or fructifications ± swollen, bleached, later often withered. Perithecia often crowded, black, embedded. *Xanthoria parietina* (Linnaeus) Fries.

(Ascom.) Dothideales – ***Sphaerellothecium parietinarium*** (Lindsay) Hafellner & V. John

[= *Discothecium gemmiferum* var. *physciicola* (Nylander) von Keissler, = *Endococcus parietinarius* (Lindsay) Clauzade & Cl. Roux]

HB. 7650. Perithecia 60–130 µm across, according to Spooner (2008) only 50 µm across. Asci contain 8 brown, 4–6 x 9–13 µm smooth spores. Fungus only exceptionally cecidogenic. F, GB (England), rare; Hawksworth, 1982, 1983a. – Comp. von Keissler; Spooner, 2008.

– Spooner (2008) reported two more galls:

3c Spores hyaline, smooth, non-septate, 15–20 x 4–7 µm.

(Ascom.) Verrucariaceae – ***Telogalla olivieri*** (Vouaux) N. Hoffmann & Hafellner

NM. 1231. Distribution widespread, rare; Hawksworth, 1975, 1983; Spooner, 2008.

3d Spores brown, finely verruculose, 13–15 x 5–7 µm, perithecia 150–300 µm across (comp. lead 3a).

(Ascom) Pleosporales – ***Polycoccum slaptoniense*** D. Hawksworth

NM. 1232.

Xatardia – Apiaceae

1a Malformation caused by rust fungus. *X. scabra*.

(Basidiom.) Pucciniales – ***Puccinia xatartiae*** Durrieu

NM. 1233; DA. p241; WNE. F. Mayor, 1970; Brandenburger, 1985.

Plate 1 (original plate size 16.5x23.5 cm)

Abies alba Miller

1. *Melampsorella caryophyllacearum* (Link) Schroeter o I, HB. 3
   A: Witches' broom in winter, originating from a bulbous twig swelling ± 0.2×.
   B: Normal needle of silver fir 2×.
   C: Part of witches' broom in summer 0,08×.
   D: Needle of a witches' broom from under side, with aecia 1.7×.
   E: Cross section of a witches' broom needle with aecia at underside and two spermatia on the upperside ± 7× (from Ross 1932).

Acer pseudoplatanus L.

2 *Pediaspis aceris* (Gmelin) ♀♀ HB. 11
   Root with a group of galls, some with emergence holes 1.5× (from Docters van Leeuwen 1957).
3 *Pediaspis aceris* (Gmelin) ♀♂ HB. 27
   Globose galls on the leaf underside, visible on the upperside as a round disc 1x.
4. See 3, cross section 1x.
5. See 3, gall changed by inquiline 1x.
6. *Aceria macrorhyncha* (Nal.) HB. 48
   Elongate, pointed galls 1x.
7. See 6, longitudinal section 6x.
8. *Aceria pseudoplatani* (Corti) HB. 53
   Erinea on venation at upper- and underside of leaf 1x.
9. See 8, young hairs of erineum 50x.
10. See 8, uparching of leaf caused by erinea on underside 1x.
11. See 10, young hairs of erineum 50x. (Fig. 3-11 from Ross 1911).

Achillea millefolium L.

12. *Rhopalomyia millefoliii* (H. Loew) HB. 80, 91
    Lower part of plant with several young bud galls 1×.
13. Older bud galls on stem 1×.
14. See 13, longitudinal section 1× (from Ross 1911, 1916)

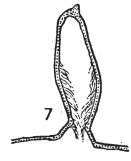
Achlya racemosa Hildebr.

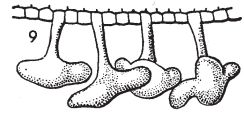
15. *Rozellopsis simulans* (A. Fischer) Karling HB. 130
    Host hypha partly partitioned by cross-walls, with parasite plasmas.
16. Two zoospores.
17. Host oogonium containing dormant sporangia of the parasite.
18. Intercalary oogonium with two dormant sporangia of the parasite.
    Fig. 15-18 Greatly enlarged to different degrees (from Cejp 1959).


1
A
E
C
D
B

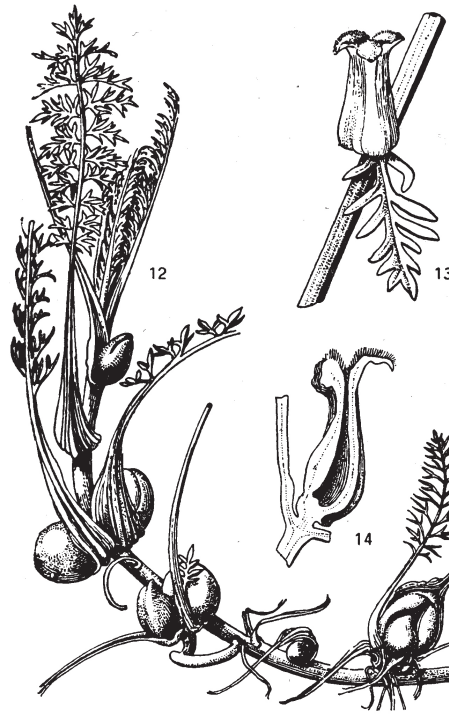

2

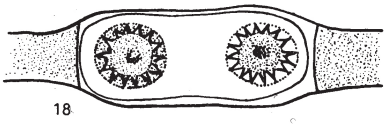

4
6
6
10
10
5
3
8
8
3

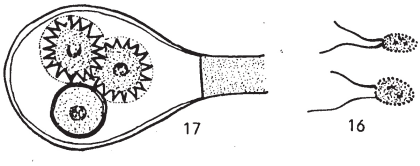

7

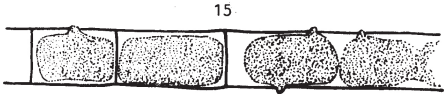

9

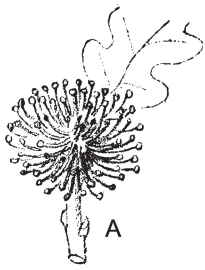
11


12
13
14

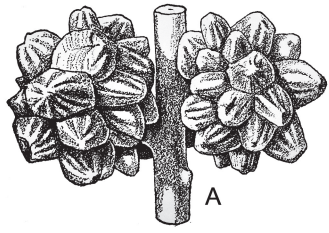

18


17
16

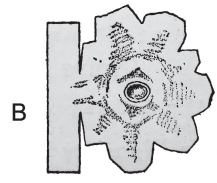

15

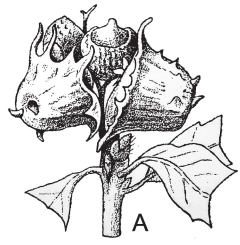


488

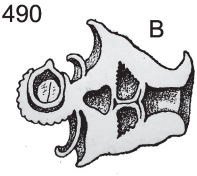


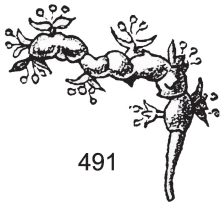
489



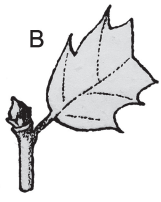


490

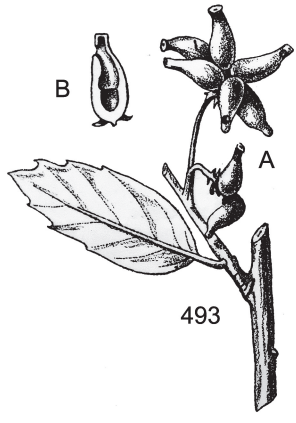




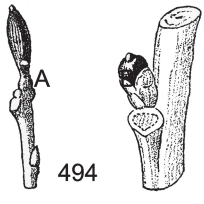
491



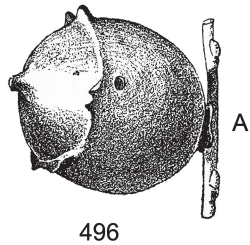
492



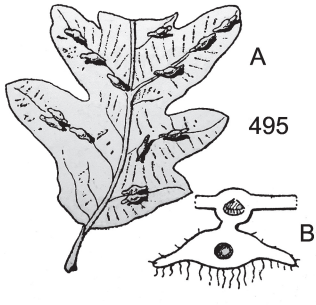
493



494



496



495

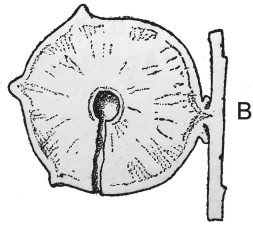


Plate 31

Quercus robur L.

497. *Andricus galeatus* (Giraud) ♀♀ [= *Cynips galeata*] H. 1236
Twig with bud galls.

498. *Andricus serotinus* (Giraud) ♀♀ H. 1220
Twig with bud galls.

499. *Andricus aries* (Mayr) ♀♀ [= *Cynips aries*] H. 1235
A: Twig with bud galls.
B: Longitudinal section of gall.

500. *Andricus caliciformis* (Giraud) ♀♀ [= *Cynips caliciformis*] H. 1244
A: Twig with bud galls.
B: Longitudinal section of gall.

501. *Andricus gemmeus* (Giraud) ♀♀ [= *A. kirschbergi*] H. 1245
A: Twig with bud galls.
B: Detail.

502. *Andricus hungaricus* (Hartig) ♀♀ [= *Cynips hungarica*] H. 1247
A: Twig with bud gall.
B: Longitudinal section of gall.

503. *Andricus mitratus* (Mayr) ♀♀ [= *Cynips mitrata*] H. 1275
A: Bud galls on rather thin branches, often also in a leaf axil. The gall consists of a lobed, cushion-shaped basal part that partly wraps around the branch, and a cylindrical central part.
B: Longitudinal section of gall.

504. *Andricus truncicolus* (Giraud) ♀♀ [= *Cynips truncicola*] H. 1243
A: Branch with disfigured accessory buds.
B: Longitudinal section of gall.

505. *Andricus gallaeurnaeformis* (Boyer de Fonscolombe) ♀♀ H. 1341
Galls of underside of leaf.

506. *Andricus stefanii* (Kieffer) ♀♀ [= *A. keszthelyensis*] H. 1272
A: Twig with bud gall.
B: Longitudinal section of gall.

507. Unidentified gall wasp H. 1274
Twig with galls.