

Lecture 4

23/02/2023

Trophic specialisation

Omnivory, herbivory–phytophagy, carnivory, detritophagy

Polyphagous insects

Can feed on plants from several plant [or animal] families, i.e. are dietary generalists

Oligophagous insects

Can feed on plants from only one plant [or animal]family i.e. are dietary specialists

Monophagous insects

Can feed on plants from only one plant [or animal] species, i.e. are extreme dietary specialists

Trophic specialisation

- ✓ Herbivorous insects are more specialized in comparison to other trophic groups
- ✓ Most herbivorous insects are oligophagous
- ✓ Many were believed to be even monophagous, but closer examination across their entire geographic range showed a broader host plant range
- ✓ The endoparasitic feeding guilds (leaf miners, gall-inducers) are most highly specialised; UK: 70% of the leaf miners are monophagous

- ✓ Sap-sucking insects are very specialized, too; UK:60% of Cicadas are monophagous

Advantage of specialization:

- 1. Efficient use through specialized metabolism for digestion and detoxification:**
- 2. Avoidance of competition, i.e. a private niche‘**

Disadvantages of specialization:

- 1. Tied to the fate of the food plant(s)**
- 2. Problems with host plant finding?**
- 3. Restricted to geographic range of food plant(s)**

Gall induction

Insect-induced plant **galls** result from a very specialized type of insect—plant interaction in which the morphology of plant parts is altered, often substantially and characteristically, by the influence of the insect. Generally, galls are defined as pathologically developed cells, tissues, or organs of plants that have arisen by hypertrophy (increase in cell size) and/or hyperplasia (increase in cell number) as a result of stimulation from foreign organisms. Some galls are induced by viruses, bacteria, fungi, nematodes, and mites, but insects

cause many more. The study of plant galls is called **cecidology**, gall-causing animals (insects, mites, and nematodes) are **cecidozoa**, and galls induced by cecidozoa are referred to as **zoocecidia**.

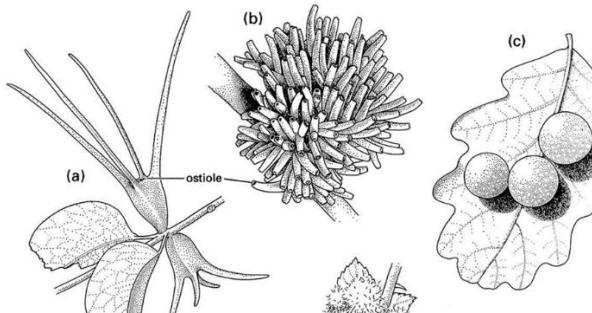
On a world basis, the principal cecidozoa in terms of number of species are representatives of just three orders of insects — **the Hemiptera, Diptera, and Hymenoptera**. In addition, about 300 species of mostly tropical Thysanoptera (thrips) are associated with galls, although not necessarily as inducers, and some species of Coleoptera (mostly weevils) and microlepidoptera (small moths) induce galls. Most hemipteran galls are elicited by Sternorrhyncha, in particular aphids, coccoids, and psyllids; their galls are structurally diverse and those of gall-inducing eriococcids (Coccoidea: Eriococcidae) often exhibit spectacular sexual dimorphism, with galls of female insects much larger and more complex than those of their conspecific males (Fig. a,b). Worldwide, there are several hundred gall-inducing coccoid species in about 10 families, about 350 gall-forming Psylloidea, mostly in two families, and perhaps 700 gall-inducing aphid species distributed among the three families, Phylloxeridae, Adelgidae, and Aphididae.

The Diptera contains the highest number of gall-inducing species, perhaps thousands, but the probable number is uncertain because many dipteran gall inducers are poorly known taxonomically. Most cecidogenic flies belong to one family of at least 4500 species, the

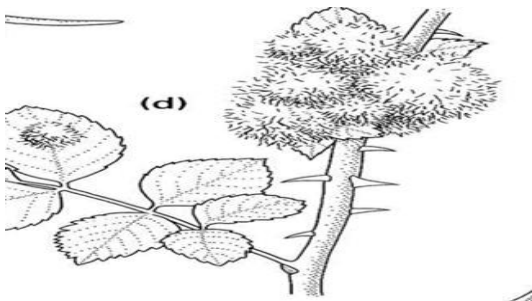
Cecidomyiidae (gall midges), and induce simple or complex galls on leaves, stems, flowers, buds, and even roots. The other fly family that includes some important cecidogenic species is the Tephritidae, in which gall inducers mostly affect plant buds, often of the Asteraceae. Gall-forming species of both cecidomyiids and tephritids are of actual or potential use for biological control of some weeds. Three superfamilies of wasps contain large numbers of gall-inducing species: Cynipoidea contains the gall wasps (Cynipidae, at least 1300 species), which are among the best-known gall insects in Europe and North America, where hundreds of species form often extremely complex galls, especially on oaks and roses (Fig. c,d); Tenthredinoidea has a number of gall-forming sawflies, such as *Pontania* species (Tenthredinidae) (Fig. g); and Chalcidoidea includes several families of gall inducers, especially species in the Agaonidae, Eurytomidae, and Pteromalidae.

Some common types of galls are:

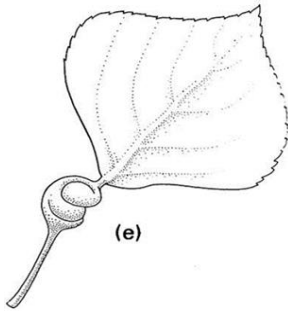
- **covering galls**, in which the insect becomes enclosed within the gall, either with an opening (ostiole) to the exterior, as in coccoid galls (Fig. a,b), or without any ostiole, as in cynipid galls (Fig. c)



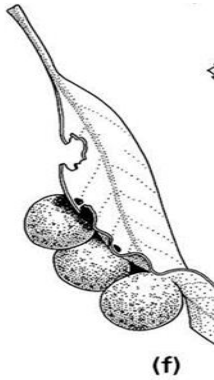
- **filz galls**, which are characterized by their hairy epidermal outgrowths (Fig. d)



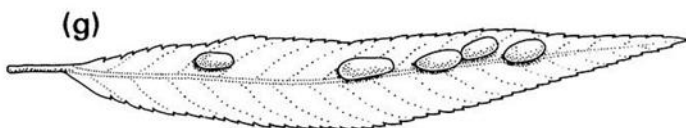
- **roll and fold galls**, in which differential growth provoked by insect feeding results in rolled or twisted leaves, shoots, or stems, which are often swollen, as in many aphid galls (Fig. e)



- **pouch galls**, which develop as a bulge of the leaf blade, forming an invaginated pouch on one side and a prominent bulge on the other, as in many psyllid galls (Fig. f)

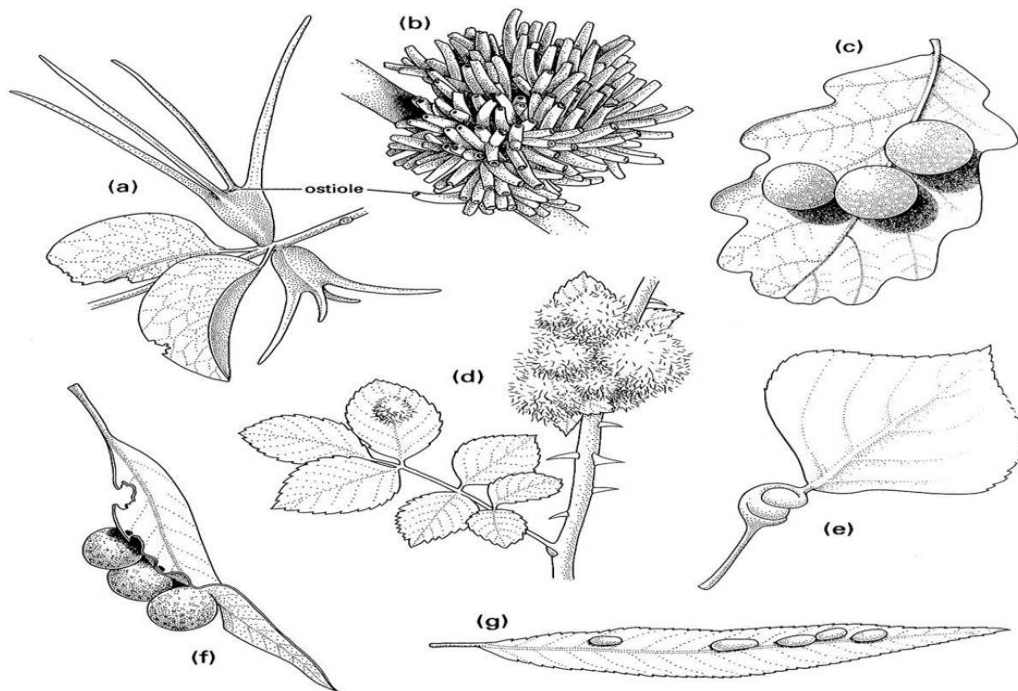


- **mark galls**, in which the insect egg is deposited inside stems or leaves so that the larva is completely enclosed throughout its development, as in sawfly galls (Fig. 11.5g)



- **pit galls**, in which a slight depression, sometimes surrounded by a swelling, is formed where the insect feeds;

- **bud and rosette galls**, which vary in complexity and cause enlargement of the bud or sometimes multiplication and miniaturization of new leaves, forming a pine-cone-like gall.



Figures . A variety of insect-induced galls:

- two coccoid galls, each formed by a female of *Apiomorpha munita* (Hemiptera: Eriococcidae) on the stem of *Eucalyptus melliodora*;
- a cluster of galls each containing a male of *A. munita* on *E. melliodora*;
- three oak cynipid galls formed by *Cynips quercusfolii* (Hymenoptera: Cynipidae) on a leaf of *Quercus sp.*;
- rose bedeguar galls formed by *Diplolepis rosae* (Hymenoptera: Cynipidae) on *Rosa sp.*;
- a leaf petiole of lombardy poplar, *Populus nigra*, galled by the aphid *Pemphigus spirothecae* (Hemiptera: Aphididae);
- three psyllid galls, each formed by a nymph of *Glycaspis sp.* (Hemiptera: Psyllidae) on a eucalypt leaf;
- willow bean galls of the sawfly *Pontania proxima* (Hymenoptera: Tenthredinidae) on a leaf of *Salix sp.*

Pharmacophagy

- Insects that are able to consume a toxic plant often sequester and make use of the toxic compounds
- Especially common in certain groups of Lepidoptera, e.g. the Monarchs (Nymphalidae: Danainae), the Passion flower Butterflies (Heliconiinae), and the „Bärenspinner“ (Arctidae)
- Monarch larvae eat milkweeds, Asclepiadiaceae that produce cardenolids, a form of cardiac glycoside (“Herzglycosid”), sequester them and adults are thereby protected from predators (e.g. birds) who learn their aposematic colors
- Mimicry



(*Limenitis archippus*)



(*Danaus plexippus*)

- Arctiid larvae are famous for sequestering highly toxic Pyrrolizidine-Alkaloids (PAs) from their food plants which makes them toxic and Provides a precursor for the male sex pheromone in some species