

BIG4 field workshop

June 5-11 2016, Havraníky, Czech Republic





BIG4 Field workshop, June 5-11 2016, Havraníky, Czech Republic

Hymenoptera

Petr Janšta



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 642241

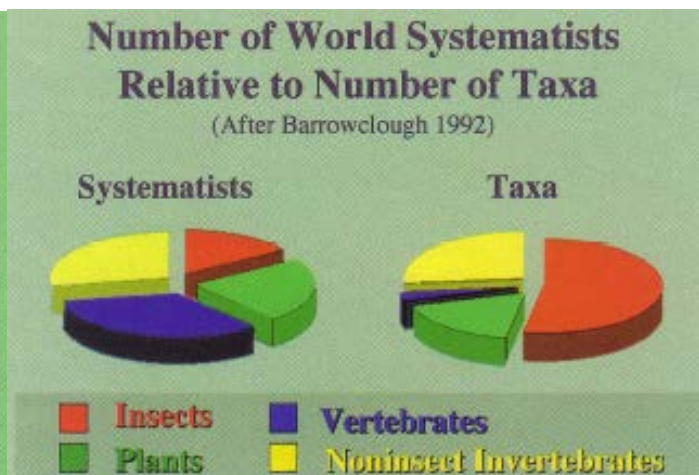
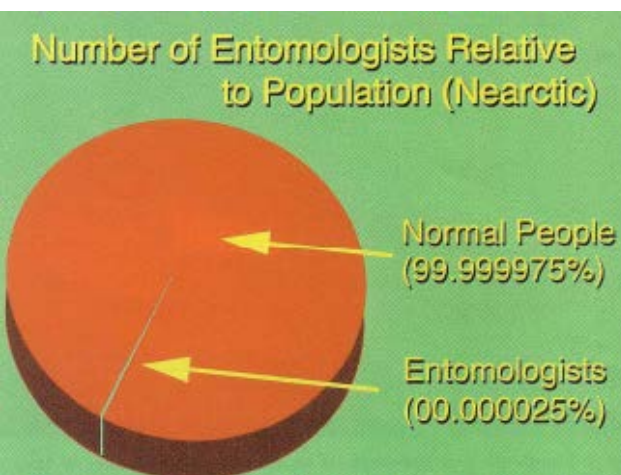
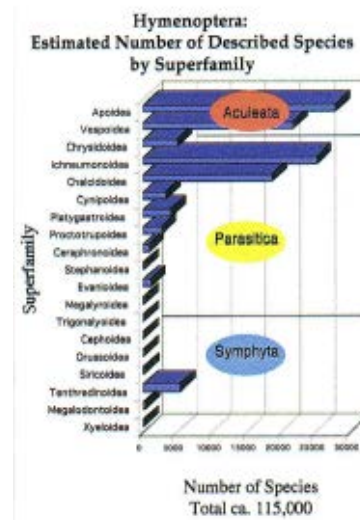


Order Hymenoptera

- ca 115 000 described spp. (in CZ 7500?) – 3rd biggest order
- BUT estimations from 300K - 3 M. (1 mil. – Sharkey, 2007)

Estimated Number of Undescribed Hymenoptera Species			
GEOGRAPHIC AREA	NUMBER DESCRIBED	ESTIMATED TOTAL	PERCENT UNDESCRIBED
North America ¹	17,500	36,000	50
Australia ¹	7,500	18,000	60
Costa Rica ^{2,3}	17,000	20,000 - 40,000	15 - 60
World ⁴	115,000	1 M	88
World ⁵	115,000	0.3 - 2 M	50 - 95
World ⁶	115,000	2.5 M	96

¹ Gaston 1993 ⁴ Gaston 1991
² Gauld and Gaston 1995 ⁵ Stock 1996
³ Gaston et al. 1996



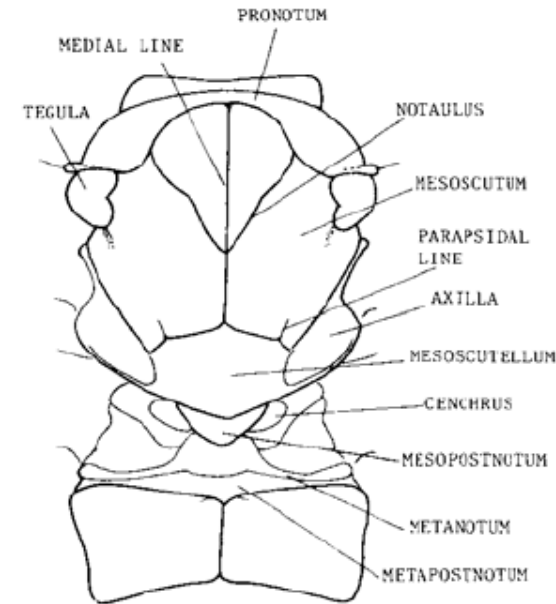
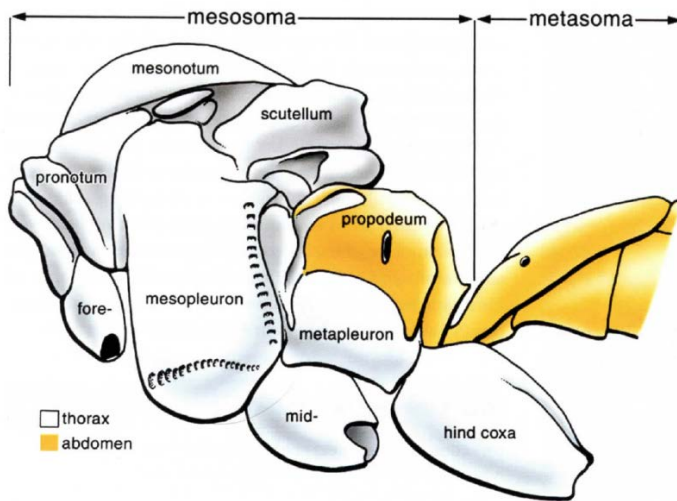
Synapomorphies of Hymenoptera

The Hymenoptera are haplo-diploid, holometabolous insects which have biting mouthparts, but which lack elytra.

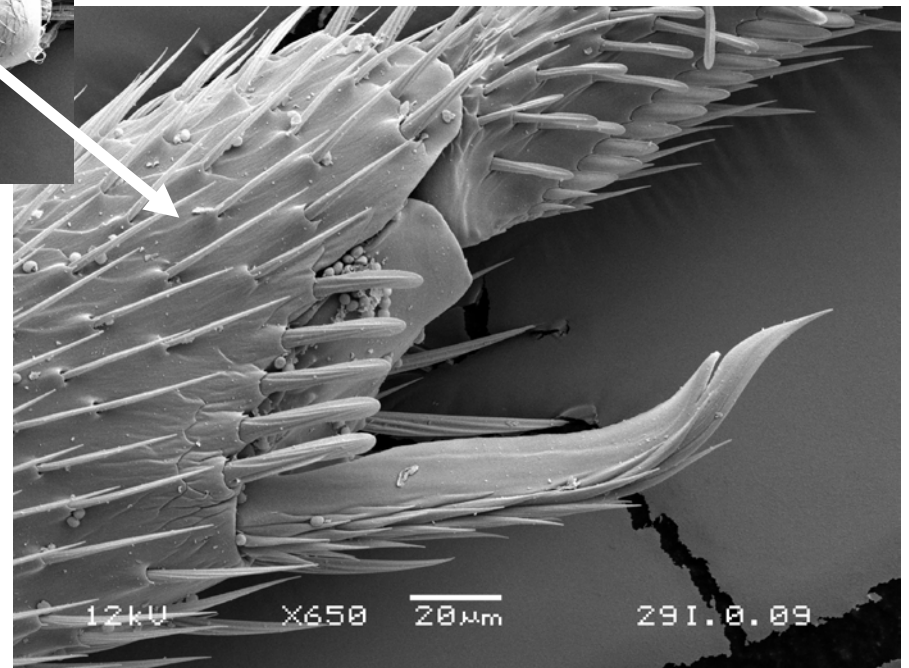
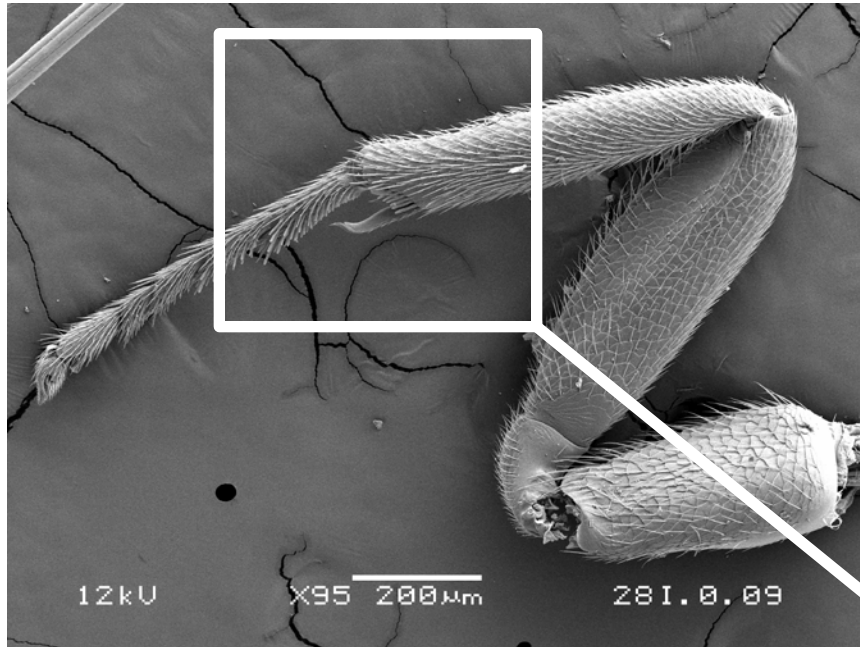
- biting mouthparts (maxilolabial complex)
- two pairs of wings with hamuli
- lepismatoid type of ovipositor
- calcar
- haplodiploid sex determination – males n , females $2n$; 2 advantages – female can chose sex of offsprings and elimination of recessive alleles

Adult morphology - thorax

- thorax vs. mesosoma (1. abdominal segment of Apocrita)
- metathorax of Symphyta – with cenchri

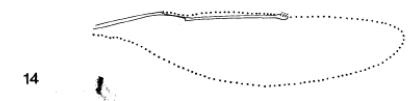
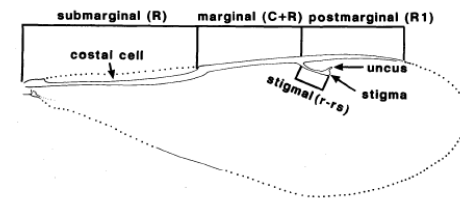
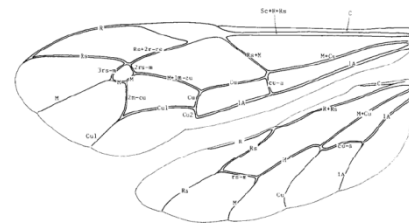
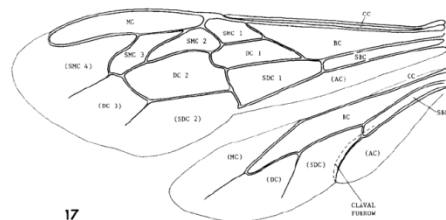
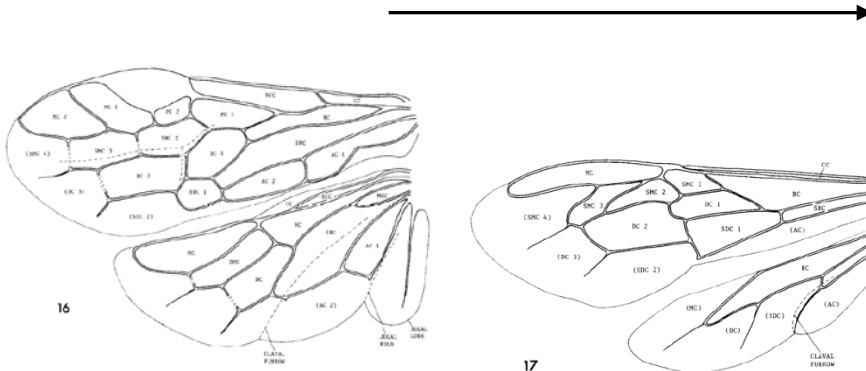
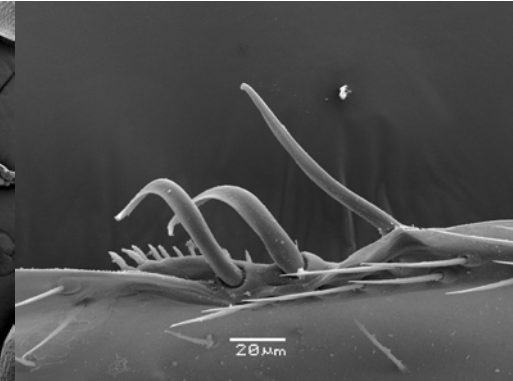
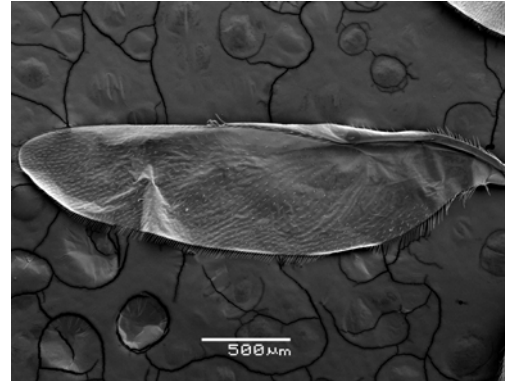


Calcar

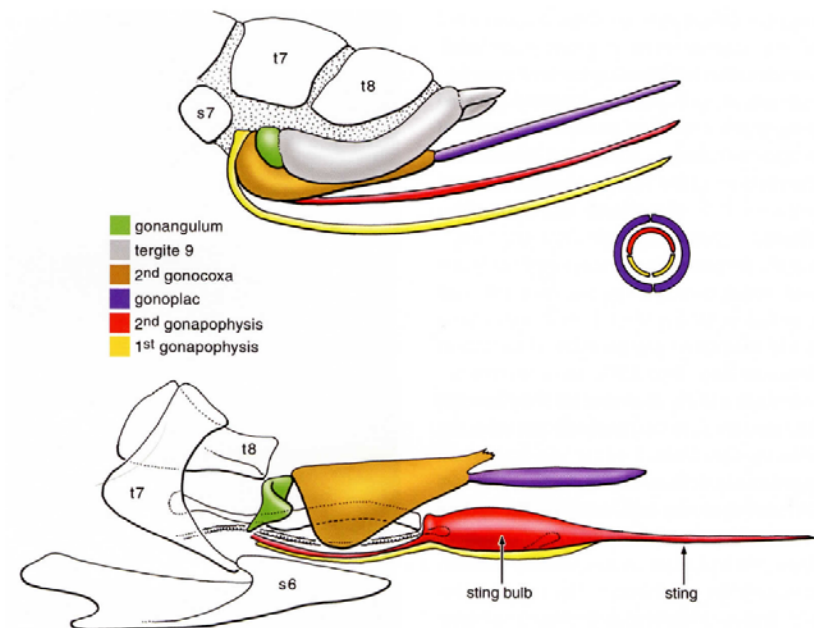
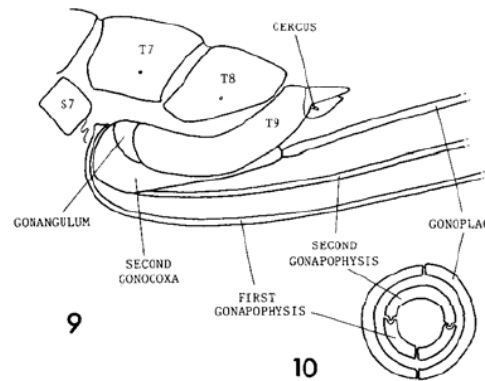


Wings and venation

- wings membranous, hindwings smaller than forewings, with hamuli
- Different type of wing venation complexity

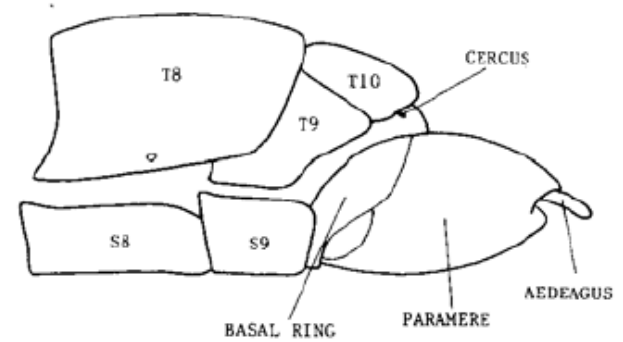
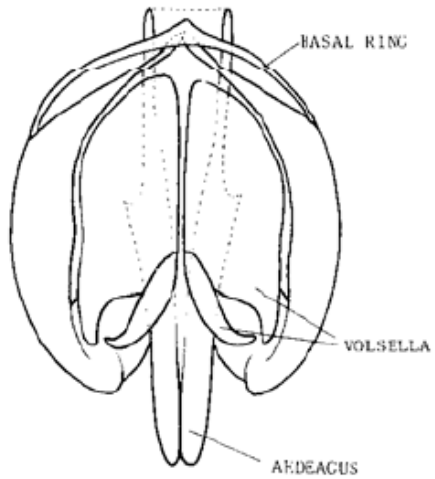


Females genitalia – ovipositor/sting

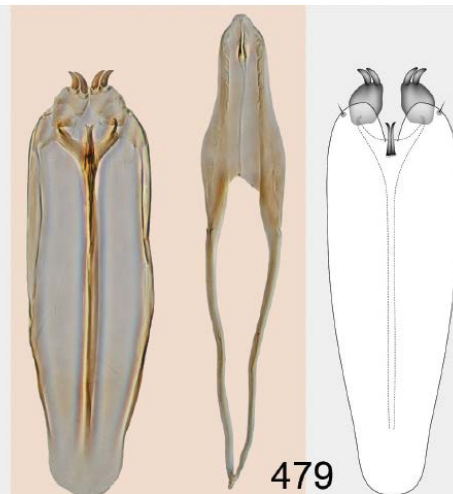
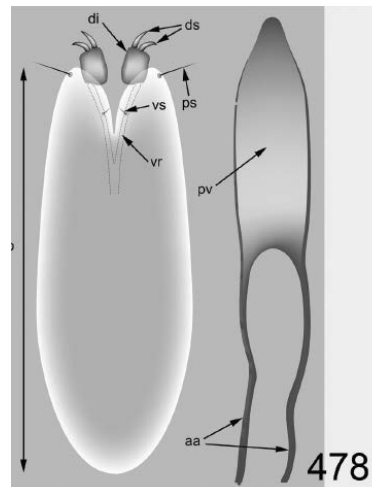


11.32. Above: a typical apocritan ovipositor; below: a generalized sting (after Rightmyer, 2004). A defining feature of the Aculeata is the sting, which is an ovipositor modified to inject venom but where eggs pass through an opening at the base of the sting.

Males genitalia



11



Larvae

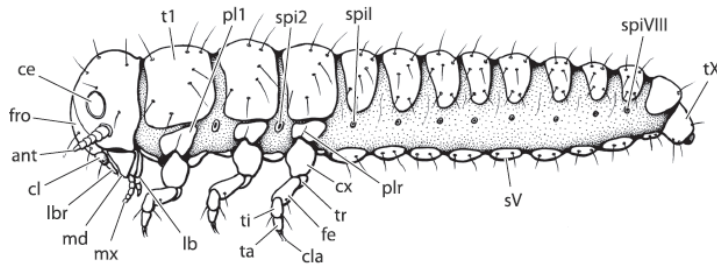
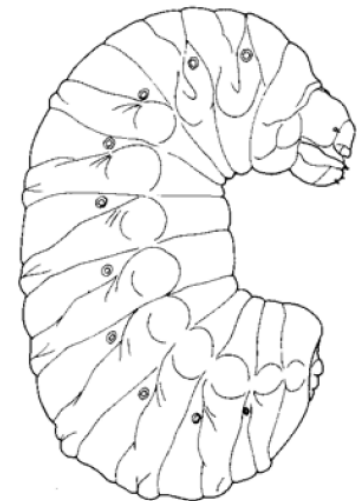
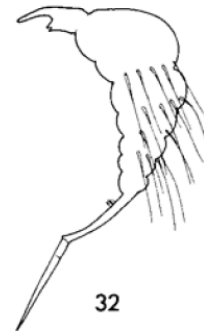
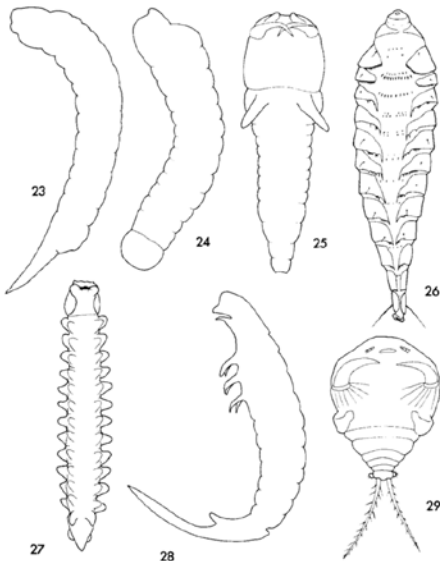


Figure 2 Illustration of reconstructed groundplan larva of Holometabola. The putative groundplan larva was orthognathous with simplified but distinctly developed compound eyes, and well developed thoracic legs. Abdominal prolegs and cerci were of larval and adult groundplan characters of Holometabola, see Table 4. ce: compound eye. fro: frons. ant: antenna. cl: clypeus. md: mandible. mx: maxille. lb: labium. t1: tergite of first thoracic segment. pl1: pleurite of first thoracic segment. spi2: spiracle of second segment. plr: pleural ridge. cx: coxa. tr: trochanter. fe: femur. tib: tibia. ta: tarsus. cla: claw. spiI: spiracle of first abdominal segment. spiVIII: spiracle of eighth abdominal segment. tX: tergite of tenth abdominal segment.



Biology

- **arrhenotoky, thelytoky; heterogony**
- Larvae diet – pollen, nectar, parasitoids, phytophagous (Stephanidae and cleptoparasitic Aculeata – combination of more diets)
- idiobionts vs. koinobionts

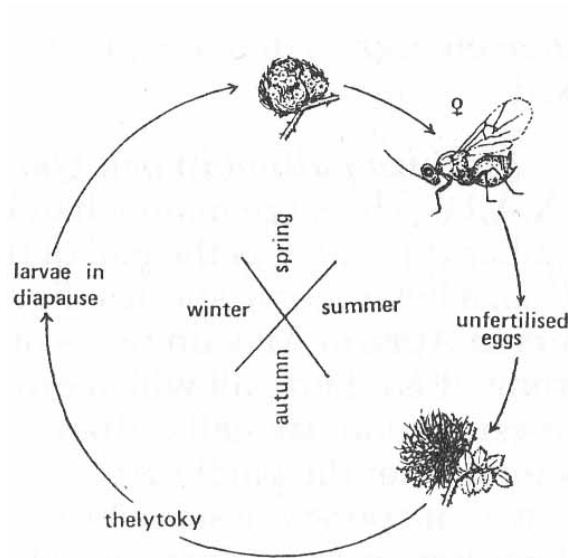


Fig. 95. Life cycle of a thelytokous cynipid *Diplolepis rosae*.

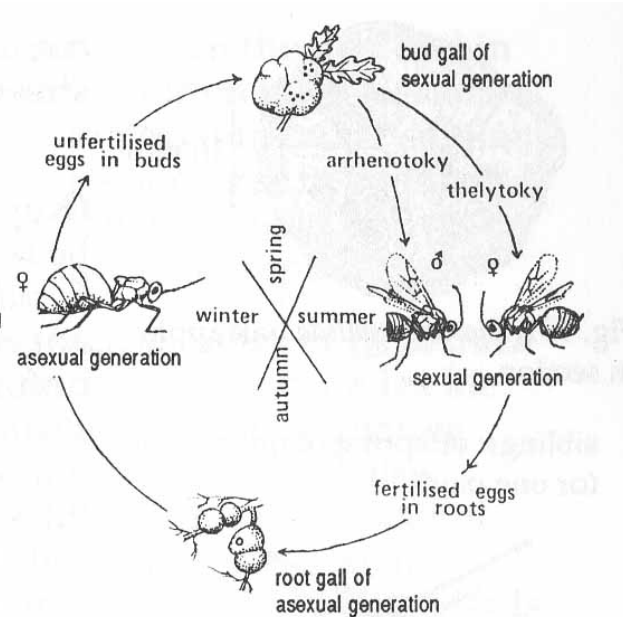
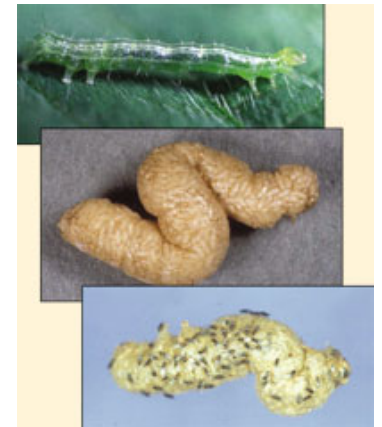


Fig. 96. Life cycle of a heterogonous cynipid *Biorhiza pallida*.

Biology

- gregarious parasitoidism – polyembryony – Braconidae, Encyrtidae, Platygasteridae, Dryinidae)



- Prestwichia aquatica*, *Agriotypus armatus*



Selected apomorphies of addressed clades:

- ① Holometabola: external wing buds absent in larval stages
- ② Aparaglossata: paraglossae vestigial or absent, without muscles
- ③ Neuropteroidea: adult head prognathous or slightly inclined
- ④ Megaloptera: setiferous lateral abdominal gills present in larvae
- ⑤ Neuroptera+Megaloptera: aquatic larvae (with reversal)
- ⑥ Coleopterida: metathorax enlarged, hindwings used as flight organs (posteromotorism)
- ⑦ Mecoptera: larval *Musculus craniodistipitalis* present
- ⑧ Mecoptera+Siphonaptera: muscle connecting profurcal arms present

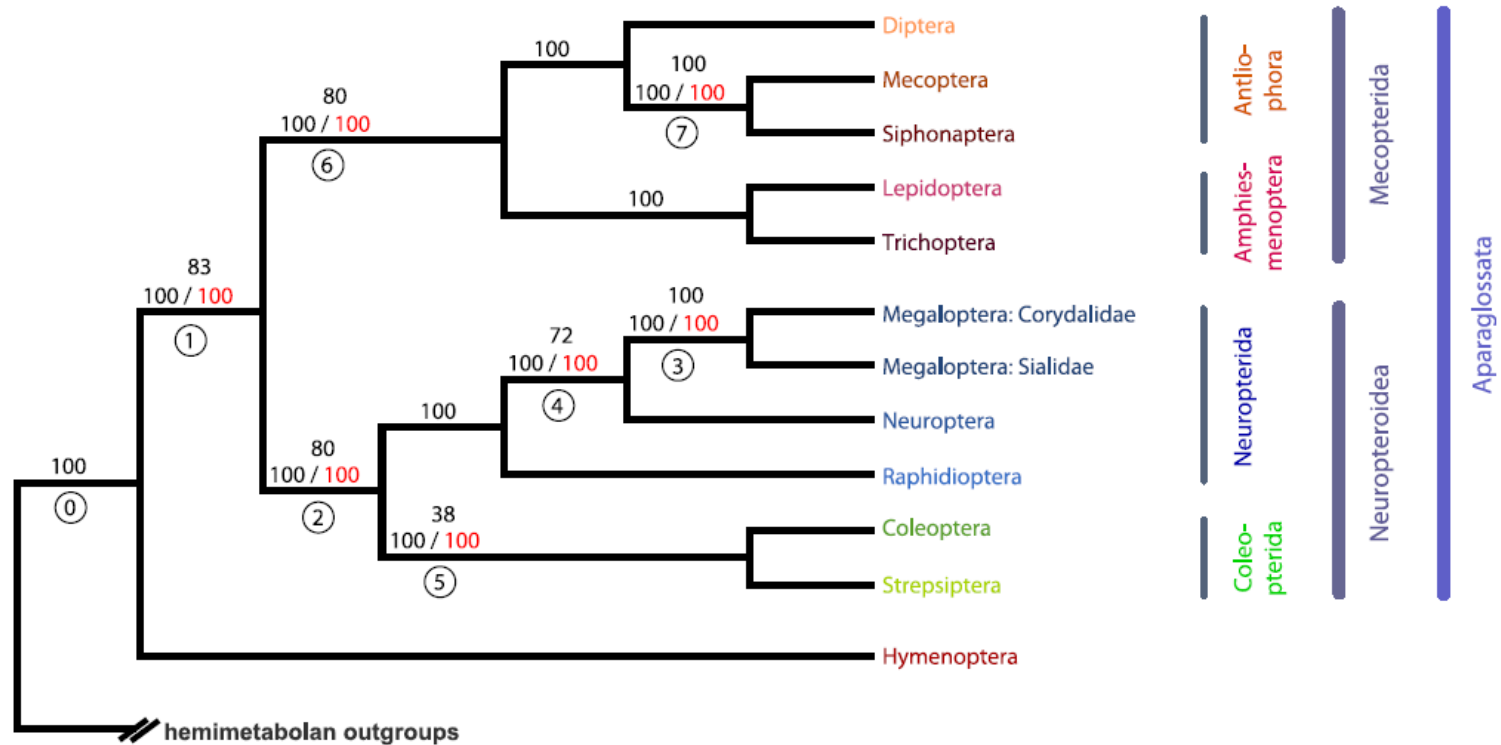


Figure 1 Combined and simplified cladogram of holometabolan insect relationships, with selected autapomorphies for the clades addressed in this study. The topology is taken from the ML tree inferred from dataset 1 (i.e., the complete datamatrix). (1) Bootstrap support (BS) (bottom, black) is derived from 72 bootstrap replicates (MRE-based bootstrapping criterion) of dataset 1. (2) BS values for the specific phylogenetic relationship (bottom, red) are derived from ML tree inferences from the seven specific decisive datasets 1 to 7. (3) relative support [%] values for the specific phylogenetic relationship (top) are derived from the Four-cluster Likelihood Mapping (FCLM) with the seven specific decisive datasets. Apomorphies are selected from the full lists of reconstructed groundplan characters (see Additional file 4, Chapter 5).

Paleontological findings

- first fossils - trias (AU, AS, AF), ca 200MY –
- common ancestor of Hymenoptera (350 – 300My – Ronquist et al. 2012, Missof et al. 2014)



11.4. The earliest Hymenoptera are some primitive xyelid species from the Triassic, such as this forewing of *Archexyela* (Xyelidae) from Mt. Crosby, Australia. Xyelidae is the sister group to all other Hymenoptera. QMF.44154; length 10 mm.



11.5. *Angarixyela vitimica* (Xyelidae) from the Early Cretaceous of central Asia. Xyelids are a small Holarctic family today (with most species in North America), and they were apparently more diverse in



11.7. *Prosyntexis gouleti*, a primitive wood wasp of the living family Anaxyelidae from the Early Cretaceous of Brazil. 120 µm. The wood wasps and horntails are xylophagous-fungivorous relatives of the parasitoid Eulymenoptera. AMNH 43270; length 12.8 mm.



11.10. *Strophonogaster magna* (Ephialtidae) from the Late Jurassic of Karatau in Kazakhstan. It was a representative of a primitive apocritan superfamily, Ephialtiboidea, which flourished in the Jurassic and Early Cretaceous. Long ovipositors in ephialtoids indicate that they were probably parasitoids of wood-boring larvae. PIN 2784/1205; body length (excluding ovipositor), 15 mm.



11.11. *Cretophlebotus kourios* (Ephialtidae), from the Early Cretaceous of Brazil, which is one of the last known occurrences of the superfamily. AMNH 46321; length 10 mm (excluding ovipositor).

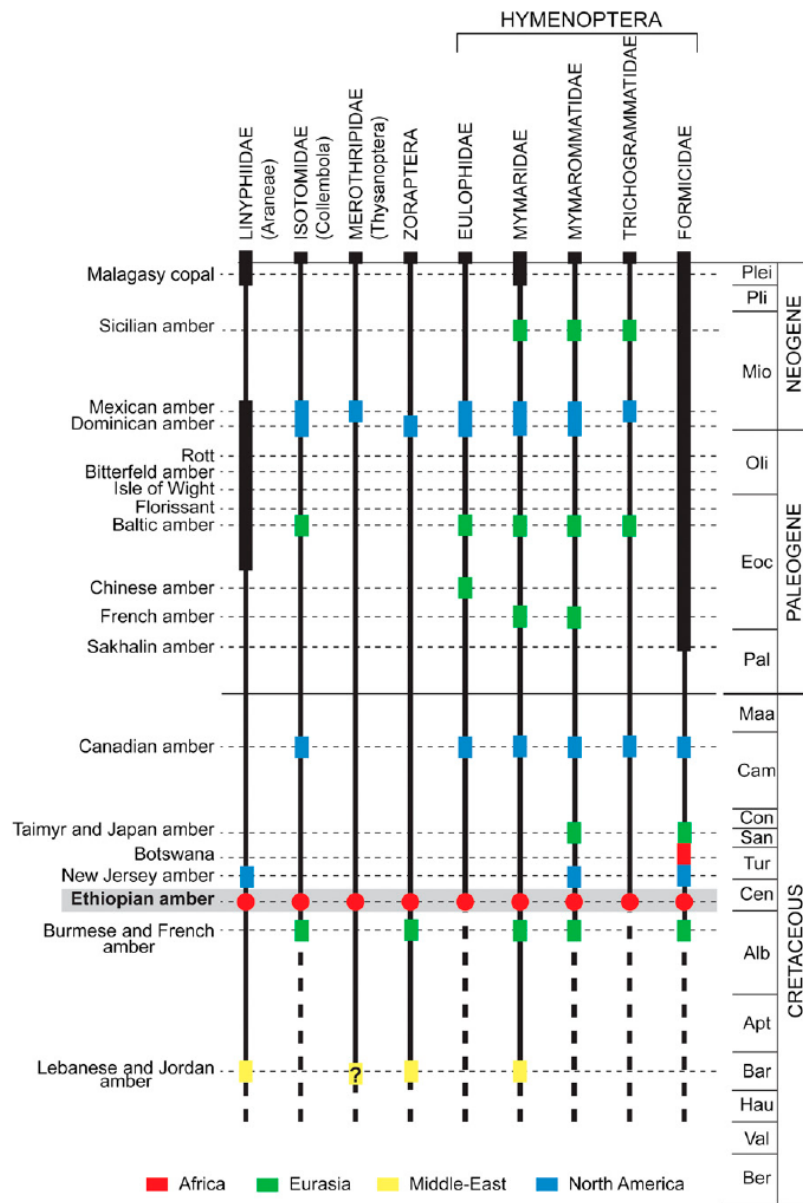
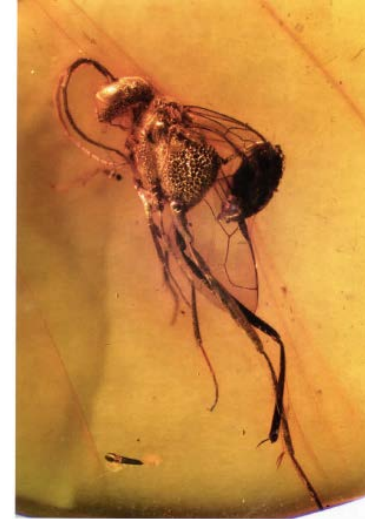


Fig. 4. Fossil record of significant arthropods found in Ethiopian amber.

Schmidt et al., 2010 – Ethiopian amber
(100 MY), Lebanese amber (120-135MY)



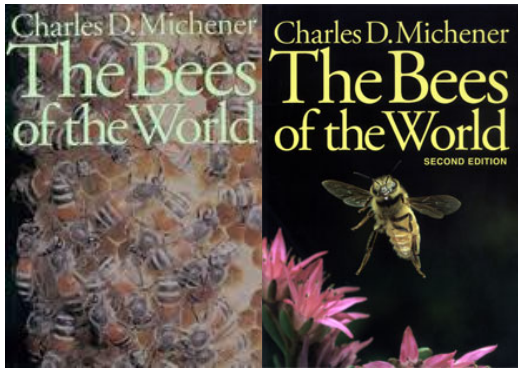
11.13. An ensign wasp (Evanidae) in Early Miocene Dominican amber. Evanidae are parasitoids of roach oothecae. Morone Collection, M0140.



11.26. Another platygastroid wasp in Lebanese amber. AMNH; length 1.9 mm.

History of Hymenoptera research

- C. D. Michener, A. P. Rasnitsyn, Z. Bouček, L. Masner



How many species? How many families?

SYMPHYTA

CEPHOIDEA
Cephidae

MEGALOGONTOIDEA
Megalodontidae
Pamphiliidae

ORUSOIDEA
Orussidae

SIRICOIDEA
Siricidae

TENTHREDINOIDEA
Argidae
Blasticotomidae
Cimbicidae
Diprionidae
Pergidae
Tenthredinidae

XVELOIDEA
Xyelidae

UNPLACED
Anaxyelidae
Xiphydriidae

APOCRITA (ACULEATA)

APOIDEA (APIFORMES)

Andrenidae
Anthophoridae
Apidae
Colletidae
Ctenoplectridae
Fidelidae
Halictidae
Megachilidae
Melittidae
Oxaeidae
Stenotritidae

APOIDEA (SPHECIFORMES)

Ampulicidae (2)
Astatidae (3)
Crabronidae (2)
Heterogynaidae

Mellinidae (2)
Nyssonidae (7)
Pemphredonidae (2)
Philanthidae (6)
Sphecidae (3)

CHRYSIDOIDEA

Bethylidae (4)
Chrysididae (4)
Dryinidae (11)
Embolemidae
Plumariidae
Sclerogibbidae
Scolebythidae

VESPOIDEA

Bradybaenidae (4)
Formicidae (10)
Mutillidae (7)
Pompilidae (3)
Rhopalosomatidae
Sapygidae (2)
Scoliidae (2)
Sierolomorphidae
Tiphidae (6)
Vespidae (6)

APOCRITA (PARASITICA)

CERAPHRONOIDEA

Ceraphronidae
Megaspilidae

CHALCIDOIDEA

Agonidae
Aphelinidae
Chalcididae
Elasmidae
Encyrtidae
Eucharitidae
Eulophidae
Eupelmidae
Eurytomidae
Leucospidae
Mymaridae
Ormyridae
Perilampidae
Pteromalidae
Rotoitidae

Signiphoridae
Tanaostigmatidae
Tetracampidae
Torymidae
Trichogrammatidae

CYNIPOIDEA

Charipidae
Cynipidae
Eucoilidae
Figitidae
Ibaliidae
Liopteridae

EVANIOIDEA

Aulacidae
Evanidae
Gasteruptionidae

ICHNEUMONOIDEA

Braconidae (30)
Ichneumonidae (32)

MEGALYROIDEA

Megalyridae

MYMAROMMATOIDEA

Mymaromatidae

PLATYGASTROIDEA

Platygastriidae
Scelionidae

PROCTOTRUPOIDEA

Austroniidae
Diapriidae
Heloridae
Monomachidae
Pelecinidae
Peradeniidae
Proctotrupidae
Roproniidae
Vanhorniidae

STEPHANOIDEA

Stephanidae

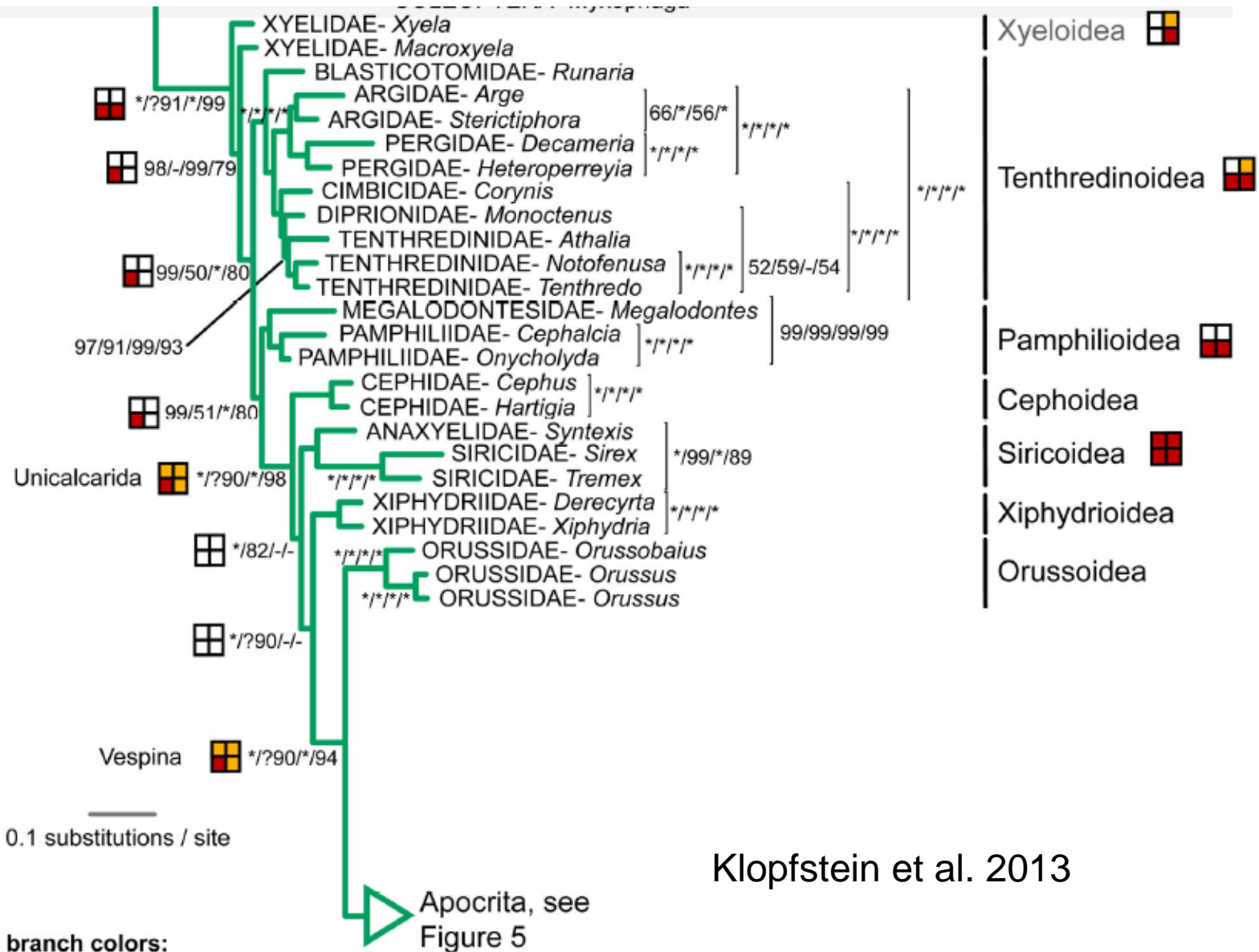
TRIGONALYOIDEA

Trigonalyidae

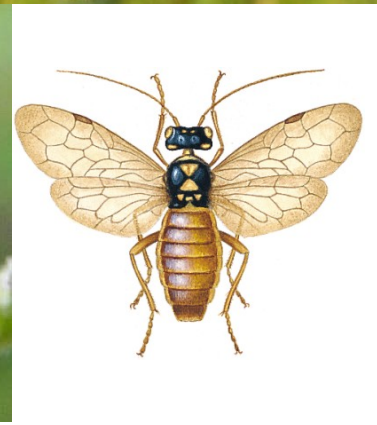
- 102 families in 21 superfamilies



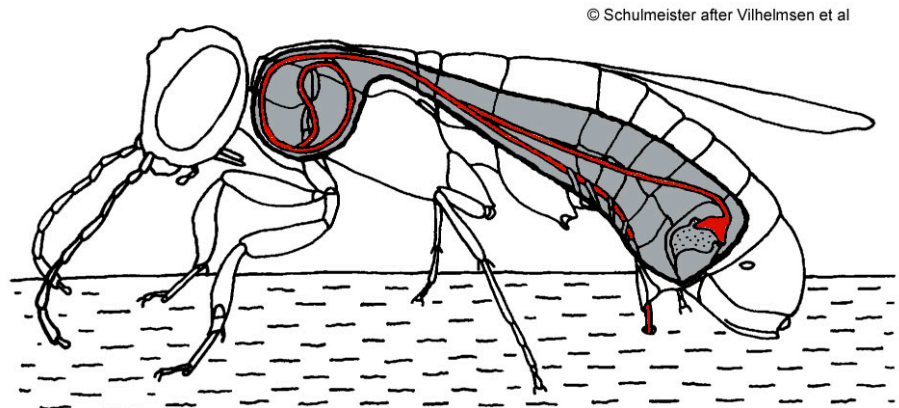
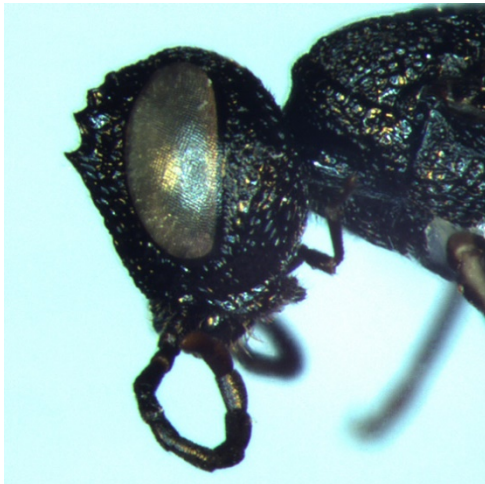
Symphphyta – sawflies, woodwasps



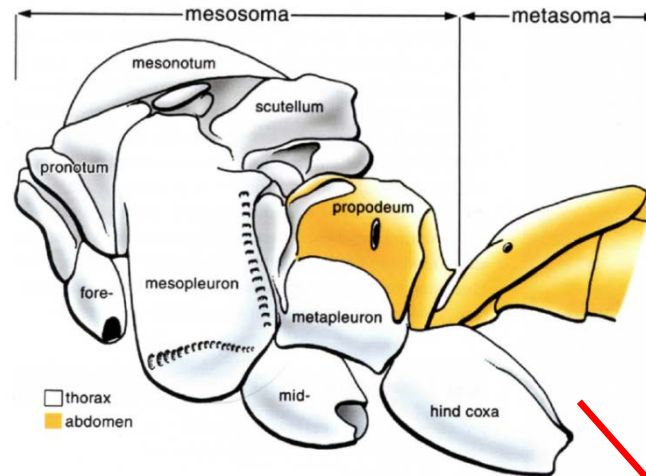
Klopfstein et al. 2013



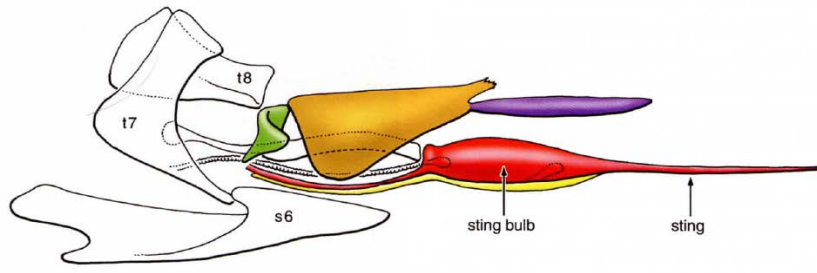
ORUSSOIDEA



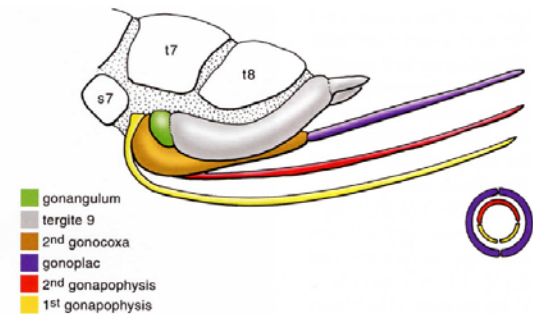
Hymenoptera - Apocrita

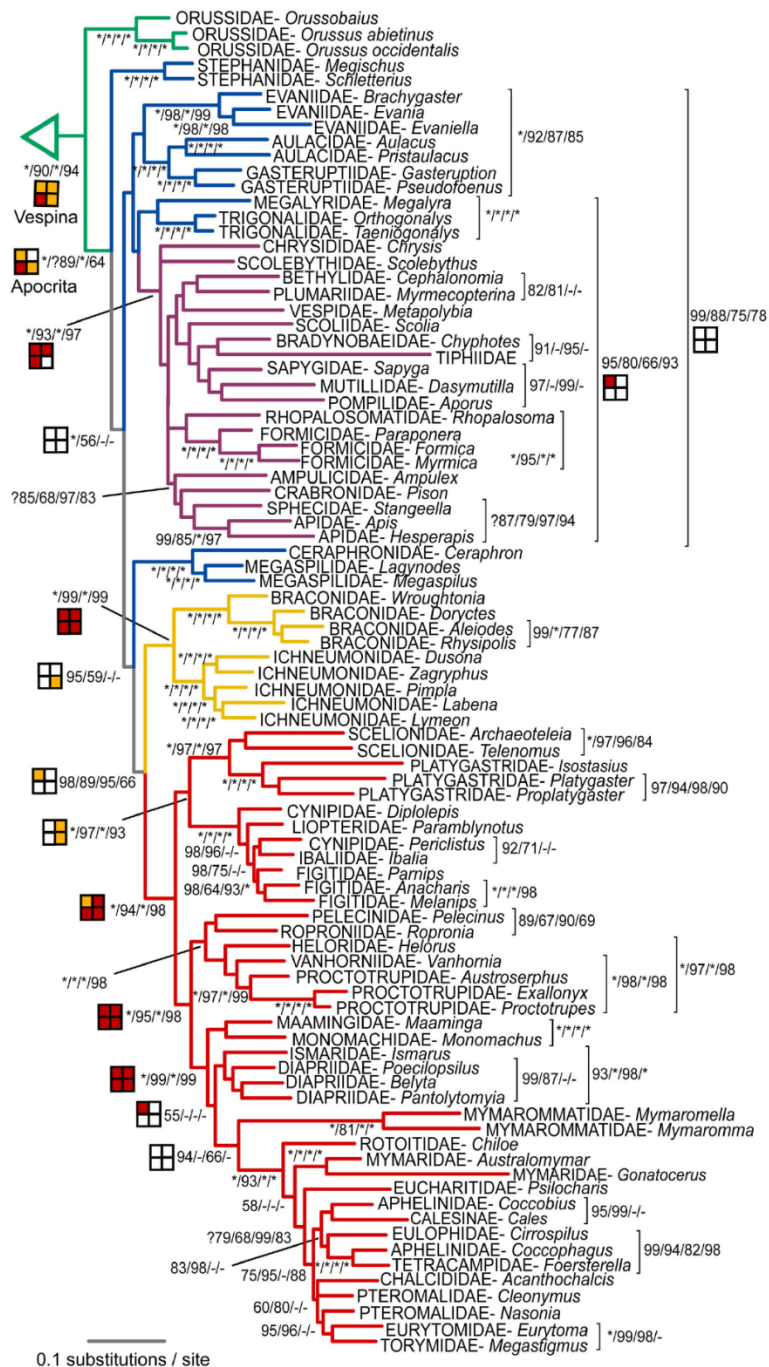


Aculeata



„Parasitica“





Orussoidea

Stephanoidea

Evanioidea

Megalyroidea

Trigonoidea

Chrysoidea

Vespoidea

Apoidea

Ceraphronoidea

Ichneumonoidea

Platygastroidea

Cynipoidea

Proctotrupoidea

Diaprioidea

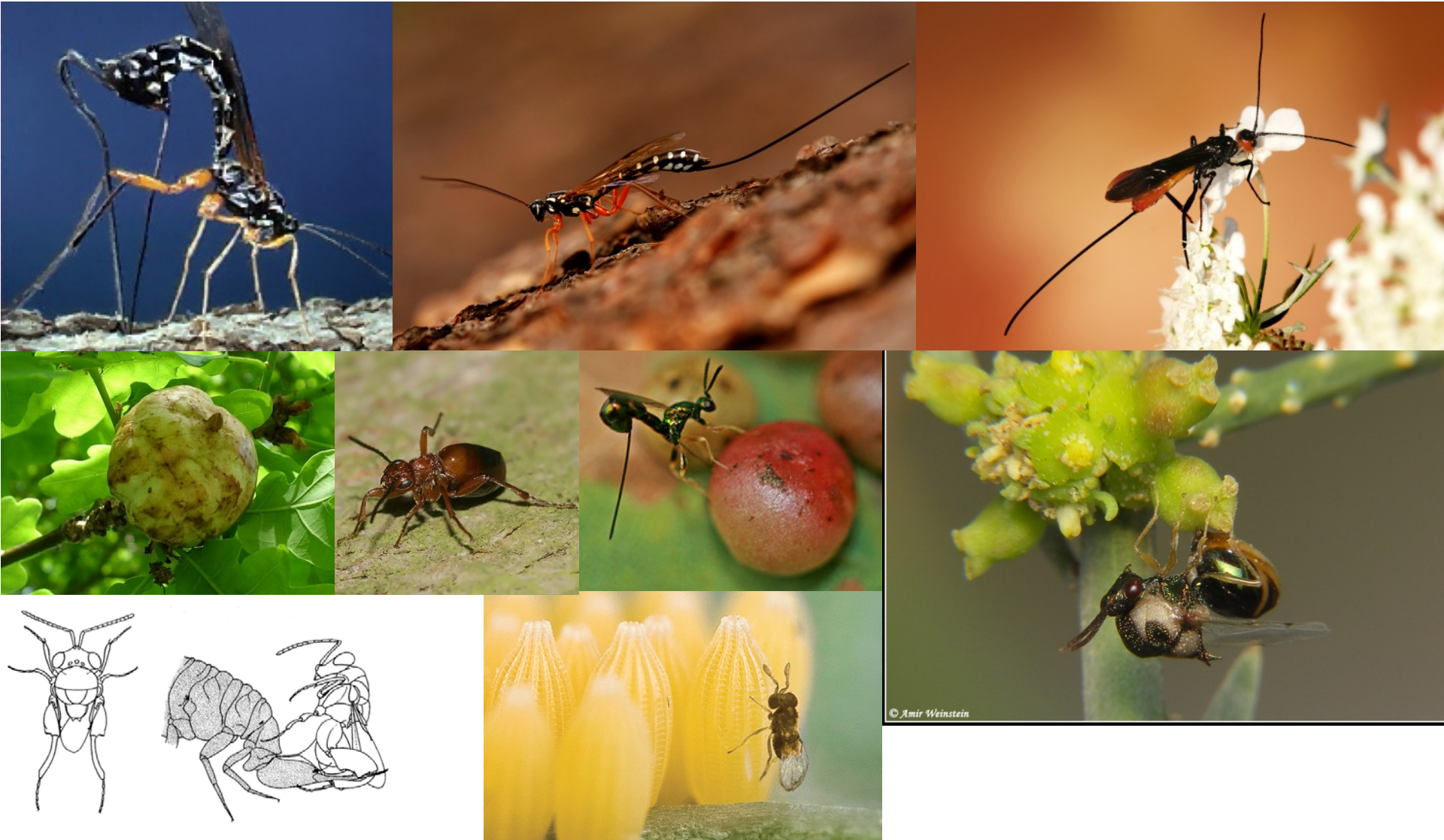
Mymarommatoidea

Chalcidoidea

Aculeata – ants, wasps, bees



„Parasitica“ – WASPS



Thanks for your attention!

