Emission of volatile organic compounds by ophiostomatoid fungi

Sylvester Menanyih
MS Student

Dr. Lori Eckhardt – School of Forestry and Wildlife Sciences, Auburn University
Dr. Jonathan Cale – Canopy Growth Corporation, Canada
Dr. Angela Calderon – Harrison School of Pharmacy, Auburn University

Background

The southeastern US is one of the most productive timber regions of the world

Pine plantations in the southeastern US covers about 14 million hectares

Loblolly is threatened by insect pest; bark beetles

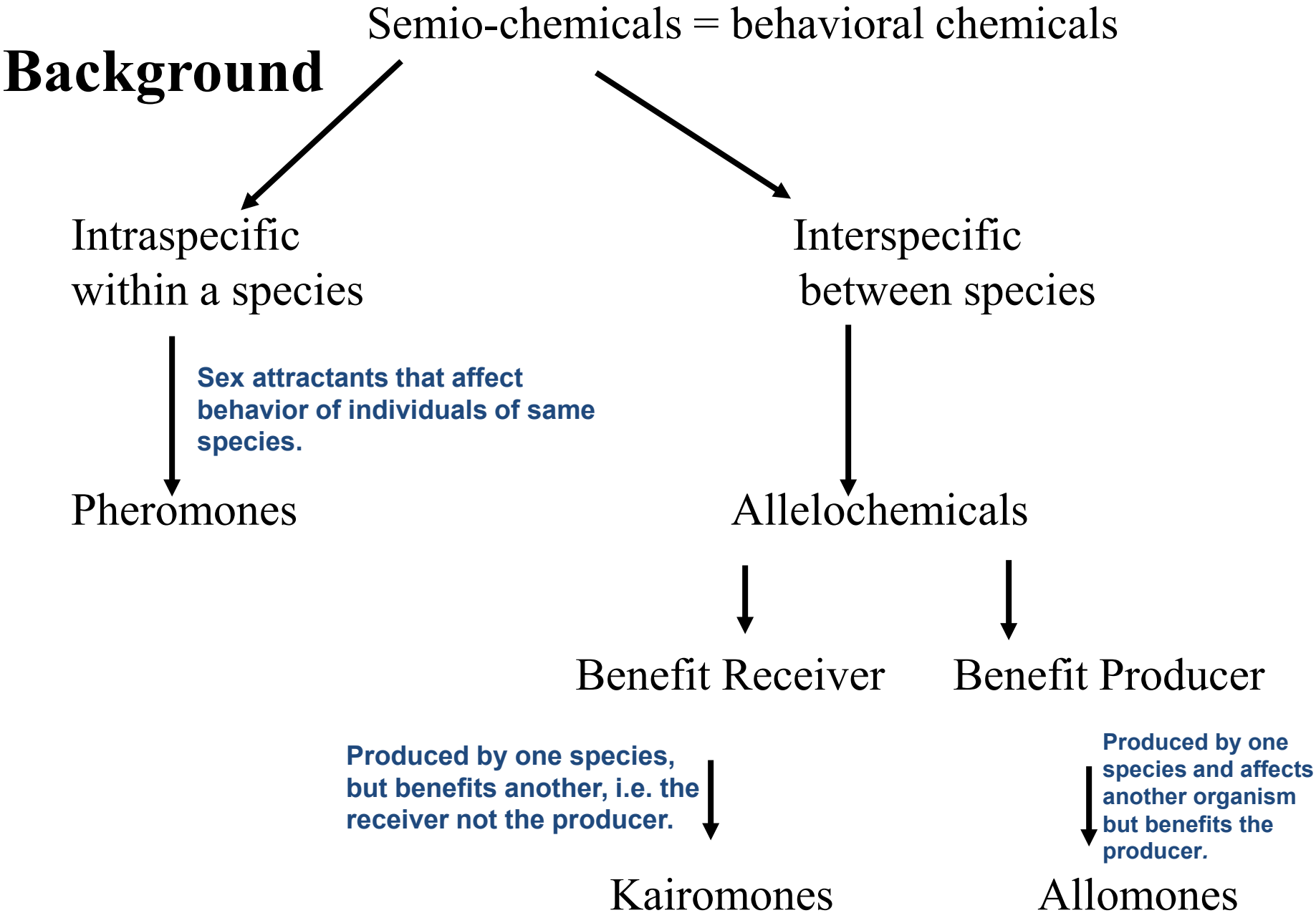
Background

Bark beetles have symbiotic association with ophiostomatoid fungi

They are noted for blue stains in the sapwood of conifer trees and logs, and black stain root disease of conifers

The fungi also cause mortality by blocking vascular tissues

Background


Semio-chemicals = behavioral chemicals
Intraspecific
within a species
Interspecific
between species
Sex attractants that affect behavior of individuals of same species.
Pheromones
Allelochemicals
Benefit Receiver
Benefit Producer
Produced by one species, but benefits another, i.e. the receiver not the producer.
Produced by one species and affects another organism but benefits the producer.
Kairomones
Allomones

Background

Bark beetles produce volatile organic compounds

- Frontalin
  - Pheromone – Sex attractant & aggregation chemical
  - Kairomone – Clerid beetles use to locate BB to feed on
- Verbenone
  - Pheromone – Anti-aggregation chemical

Pine trees produce volatile organic compounds

- Alpha & Beta pinene
  - Kairomone – attracts beetles to tree by indicating tree is stressed
  - Inhibits growth of fungi (Eckhardt et al., 2008)
- Limonene
  - Allomone – acts as repellent to bark beetles
  - Inhibits growth of fungi (Eckhardt et al., 2008)

Background

The interactions between insect pest and fungi can be mediated by Fungal Volatile Organic Compounds (FVOCs)

VOCs produced by ophiostomatoid fungi are unexplored

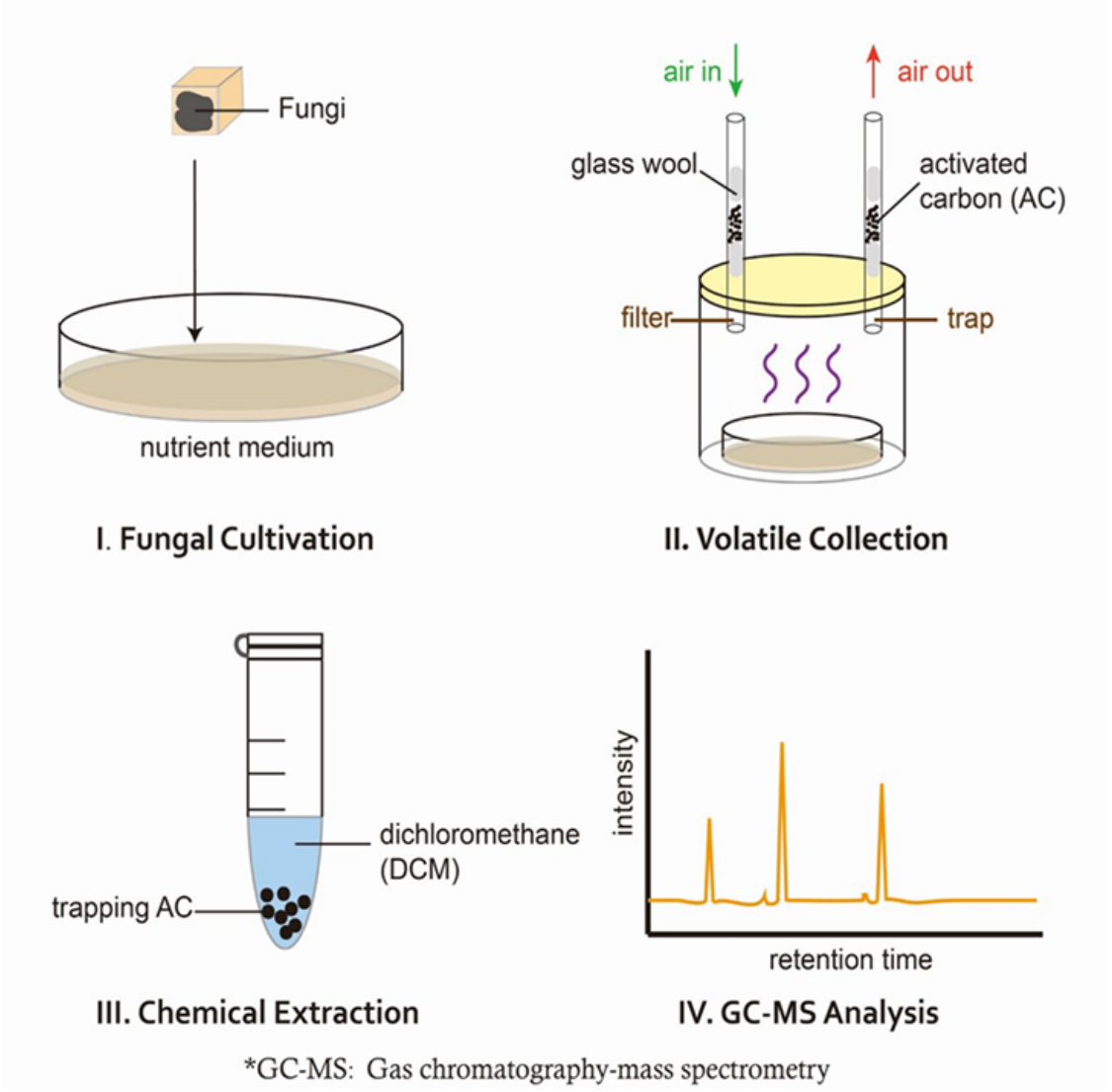
Goal

To use of VOCs as cues in insect pest management

Objective

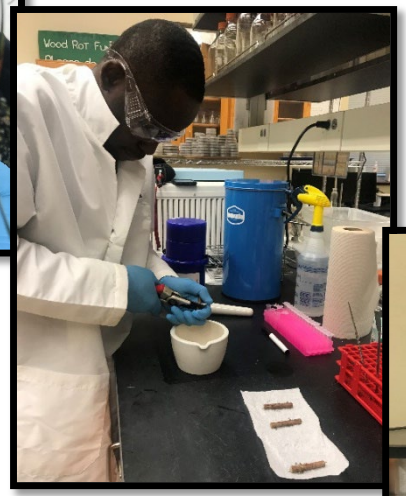
Identify VOCs associated with ophiostomatoid fungi

Materials & Methods



*GC-MS: Gas chromatography-mass spectrometry

Materials & Methods



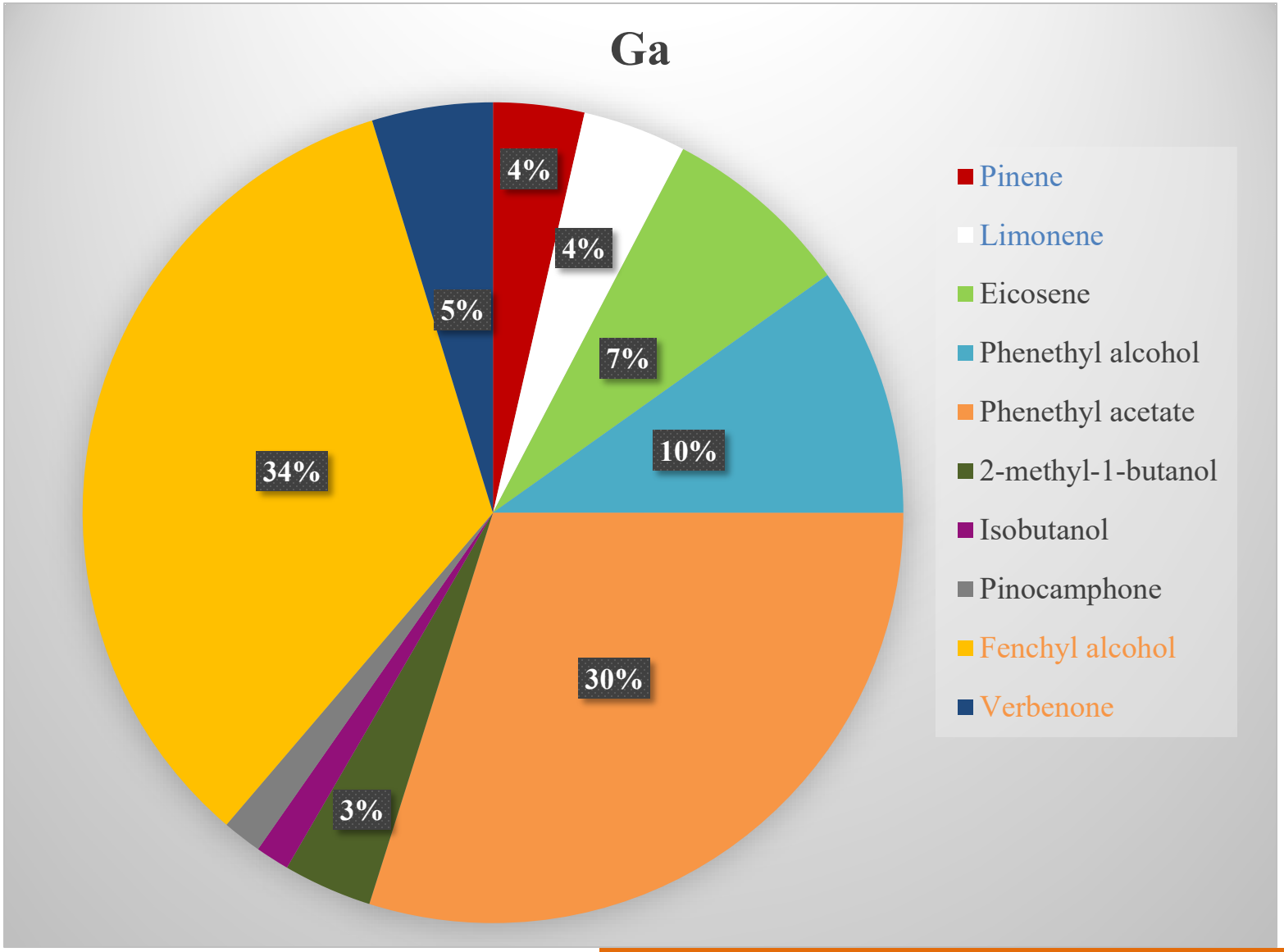
Results

Fungi	Compounds
*Grosmannia alacris,*Ga	Pinene, phenethyl acetate, Limonene, phenethyl alcohol, 2-methyl-1-butanol, pinocamphone, fenchyl alcohol, and verbenone
*Grosmannia huntii,*Gh	Pinene, phenethyl acetate, Limonene, phenethyl alcohol, 2-methyl-1-butanol, pinocamphone, fenchyl alcohol, and verbenone
Leptographium terebrantis, Lt	Pinene, phenethyl acetate, phenethyl alcohol, ethyl acetate, fenchyl alcohol, and verbenone
Leptographium procerum, Lp	Phenethyl acetate, phenethyl alcohol, pinocamphone, ethyl acetate, and verbenone

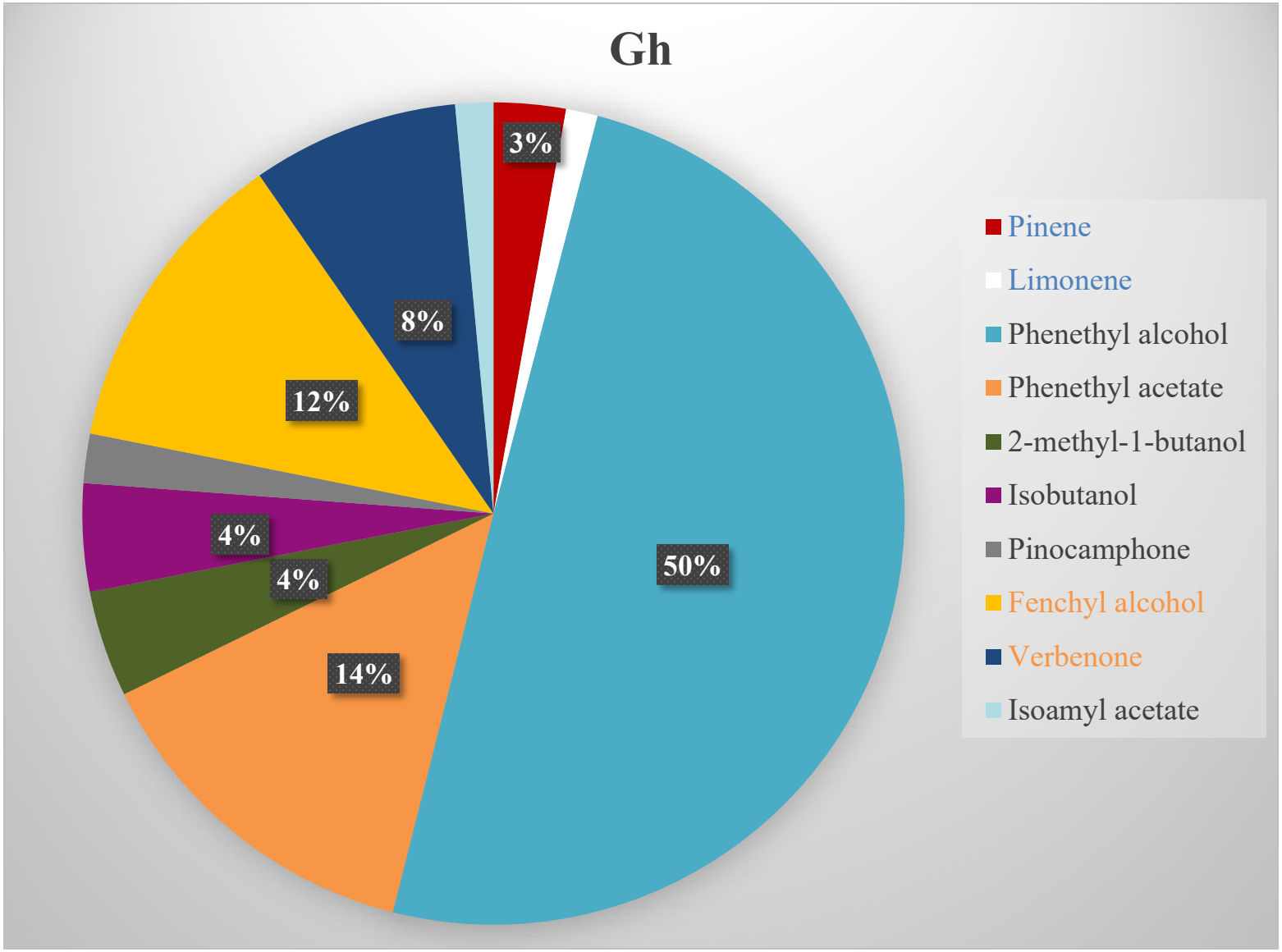
13 major compounds identified

- Insect
- Tree

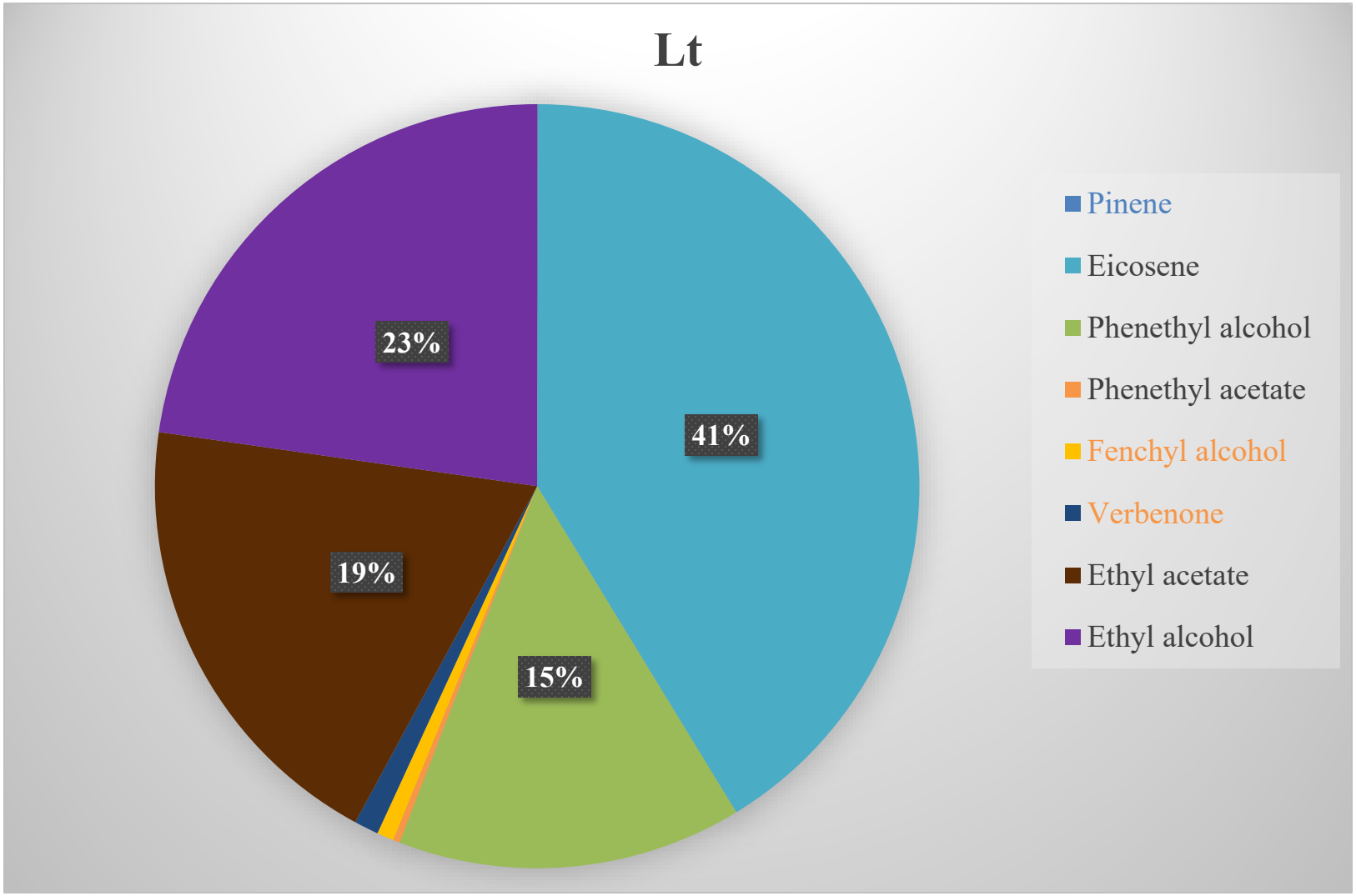
Results


Ga
4%
4%
7%
10%
30%
3%
34%
5%
Pinene
Limonene
Eicosene
Phenethyl alcohol
Phenethyl acetate
2-methyl-1-butanol
Isobutanol
Pinocamphone
Fenchyl alcohol
Verbenone

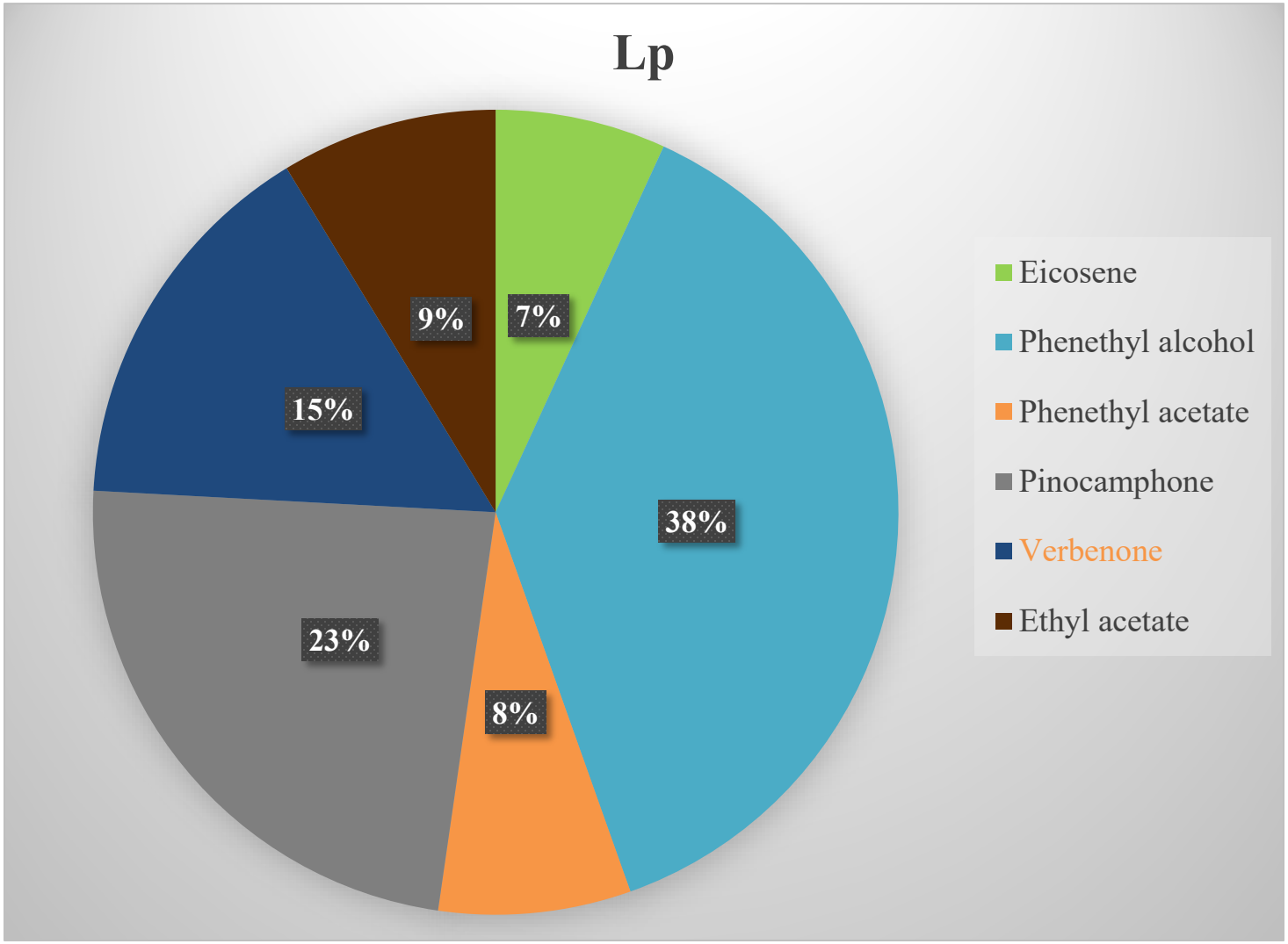
Results


Gh
3%
50%
14%
4%
4%
12%
8%
Pinene
Limonene
Phenethyl alcohol
Phenethyl acetate
2-methyl-1-butanol
Isobutanol
Pinocamphone
Fenchyl alcohol
Verbenone
Isoamyl acetate

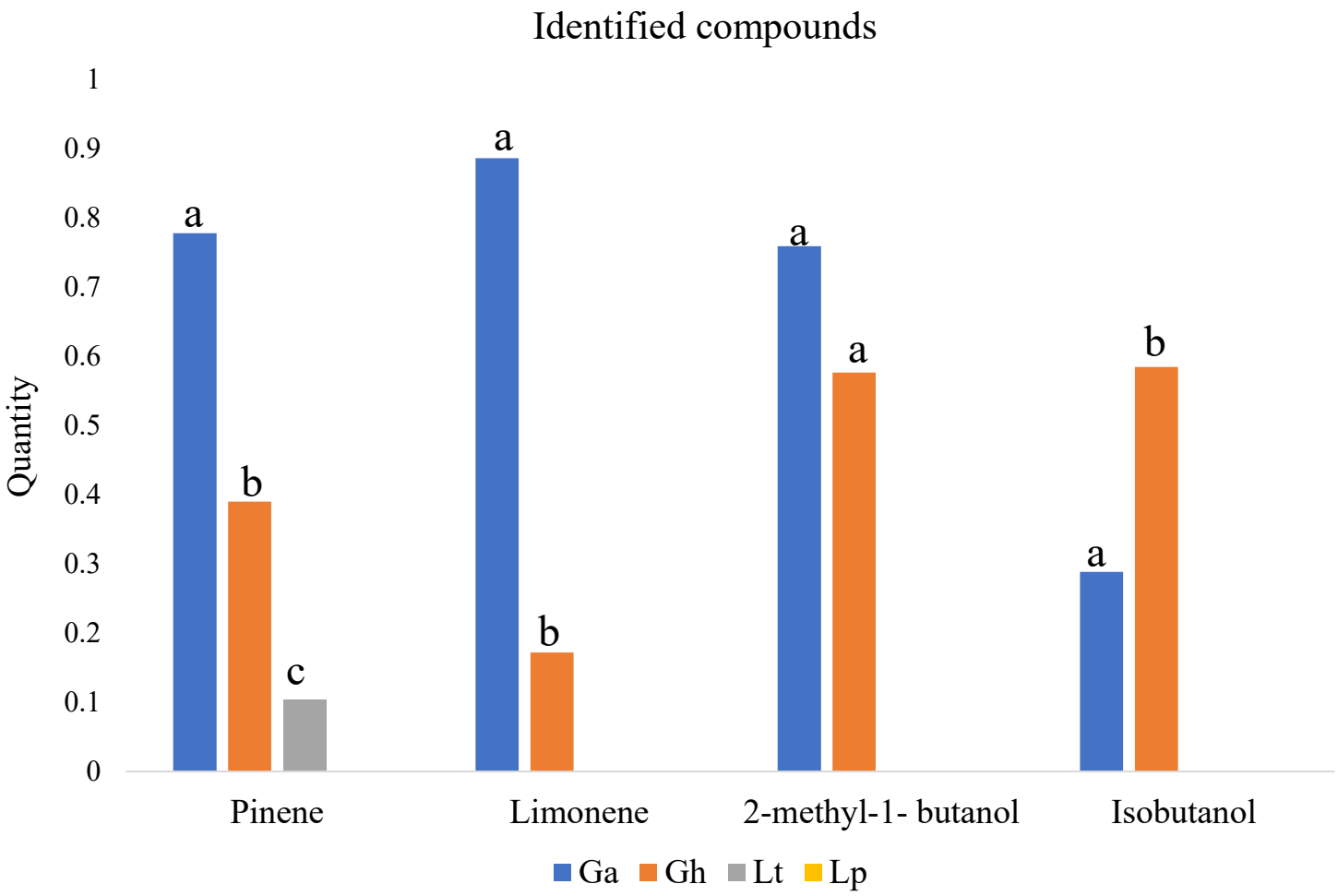
Results


Lt
41%
15%
19%
23%
Pinene
Eicosene
Phenethyl alcohol
Phenethyl acetate
Fenchyl alcohol
Verbenone
Ethyl acetate
Ethyl alcohol

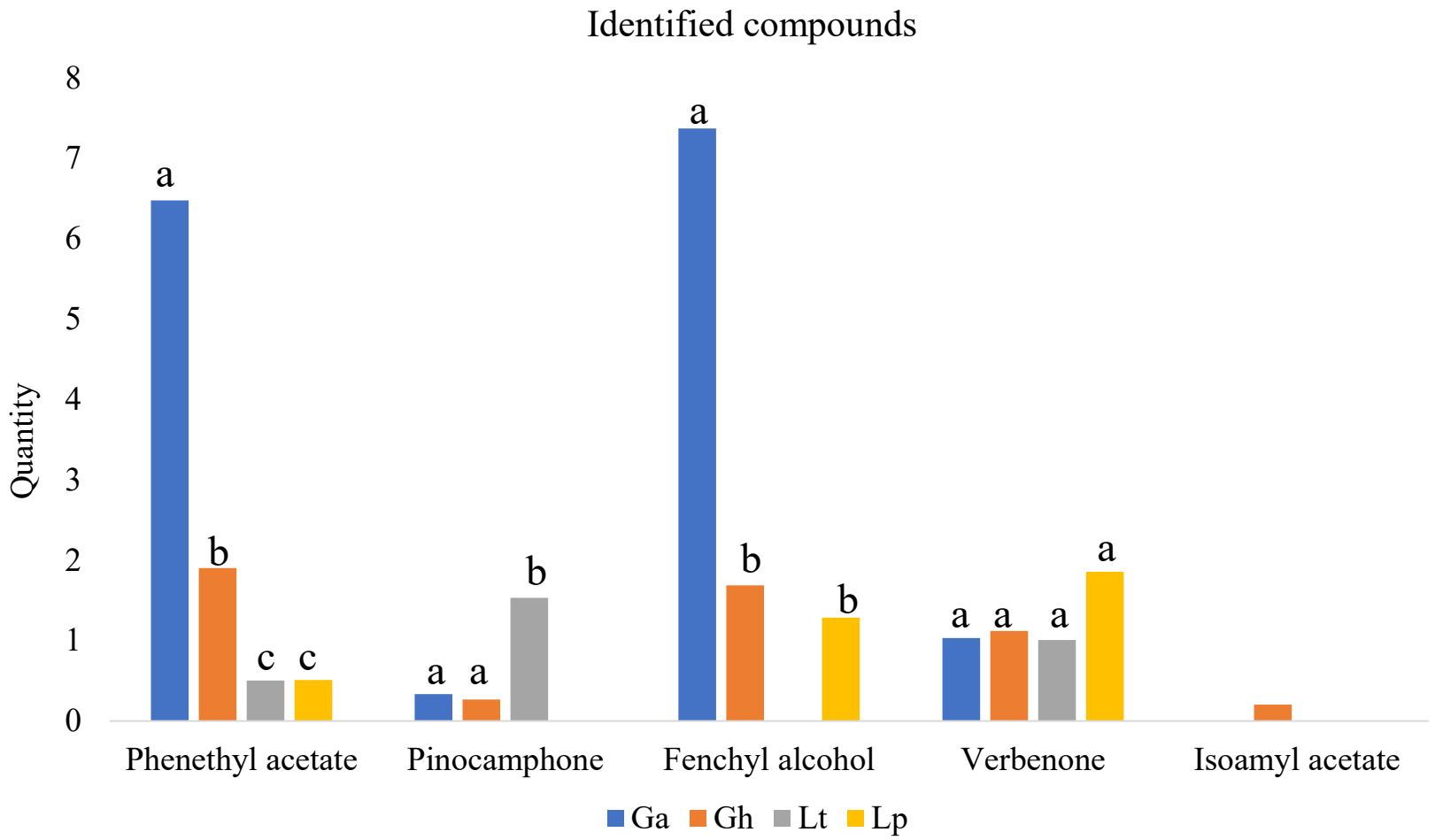
Results


Lp
7%
38%
8%
23%
15%
9%
Eicosene
Phenethyl alcohol
Phenethyl acetate
Pinocamphone
Verbenone
Ethyl acetate

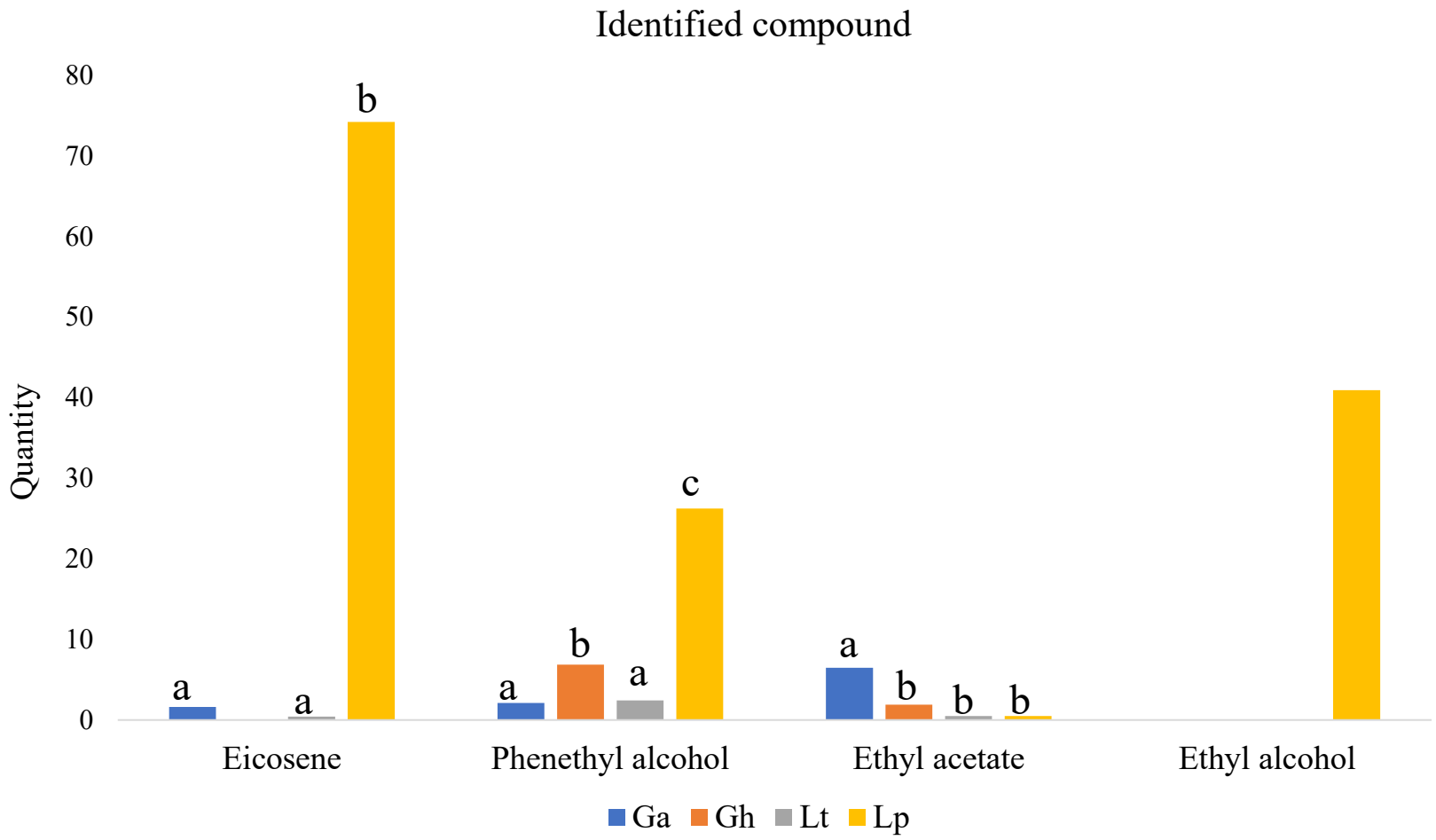
Results


Identified compounds
Quantity
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
a
b
c
a
b
a
a
a
b
Pinene
Limonene
2-methyl-1- butanol
Isobutanol
Ga
Gh
Lt
Lp

Results


Identified compounds
Quantity
8
7
6
5
4
3
2
1
0
a
b
c c
a a
b
a
b
b
a a a
a
Phenethyl acetate
Pinocamphone
Fenchyl alcohol
Verbenone
Isoamyl acetate
Ga Gh Lt Lp

Results


Identified compound
Quantity
80
70
60
50
40
30
20
10
0
a
a
b
a
b
a
c
a
b
b
b
Eicosene
Phenethyl alcohol
Ethyl acetate
Ethyl alcohol
Ga
Gh
Lt
Lp

Results

Fungi	Compounds
Grosmannia alacris	α-pinene, terpineol, limonene, myrcene, γ-terpinene, pinocarvone, and borneol
Grosmannia huntii	α- pinene, β-pinene, camphor and limonene
Leptographium terebrantis	α-pinene, β-pinene, limonene, camphor, terpineol, and trans-verbenol
Leptographium procerum	α- pinene, β-pinene, camphor and limonene

8 major compounds identified

Insect

Conclusion

- Tree compounds were more produced after fungal infection
- FVOCs profiles emitted by ophiostomatoid fungi are similar between species that share the same ecological niche
- Phenethyl alcohol, and 2-methyl-1-butanol attract several bark beetles
- Ethyl acetate may act as a deterrent

Future direction

Acknowledgements

Committee members: Dr. Lori Eckhardt (AU), Dr. Jonathan Cale (CGC), Dr. Angela Calderon (AU)

Lab managers: Jessica Baldwin, Tina Ciaramitaro, Luis Mendez, Angelica Baker, Jessica Ahl

GC-MS: Dr. Henry Fadamiro, Dr. Rammohan Balusu, Dr. Younis Abiedalla, Dr. Beatriz Iris Vega Erramuspe, Dr. Cheryl Colquhoun, Jeffery Estep

Graduate Student: John Mensah, Debit Datta, Basu Kafle

Undergraduate Student: Logan Jones, Amelia Harrison, Jaliyl Collins

Funding Agencies: Forest Health Cooperative, Forest Health Dynamics Laboratory, AU Internal Grants Program, Project Number 190567

AUBURN UNIVERSITY

CANOPY GROWTH CORPORATION

KEEPING TREES HEALTHY