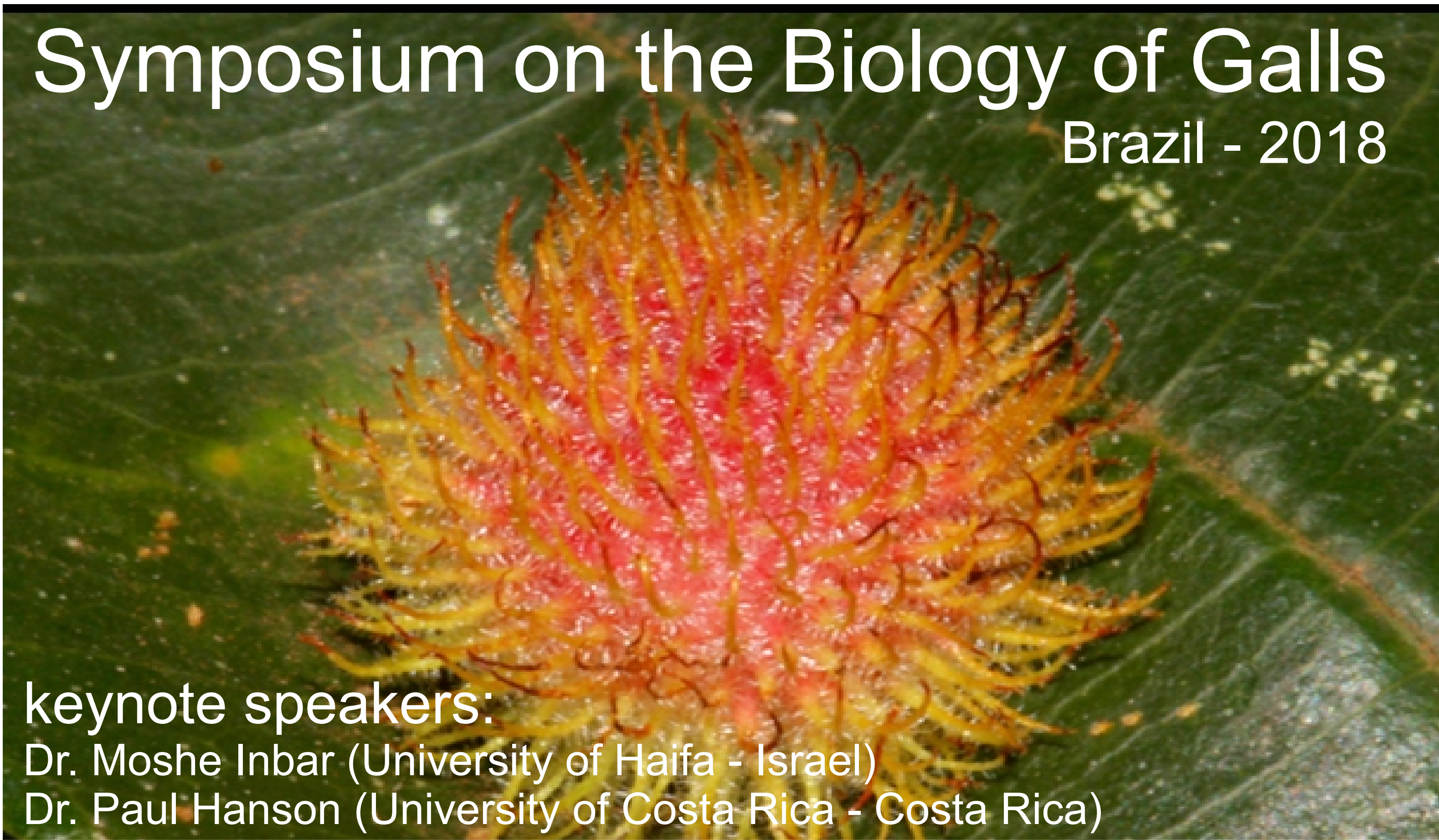

Day 1 – 15 / 11/ 2018 (18:00h) Opening session
Functional ecology of gall traits – a lesson from aphids (Moshe Inbar – University of Haifa/Israel)

Day 2 – 16 / 11/ 2018 (09:00h)
Plant gall diversity and interactions with natural enemies
10:00h – 12:00h
1. Parasitoids and inquilines of gall-inducing insects (Paul Hanson – University of Costa Rica/Costa Rica)
2. Natural history of gall-inducing psyllids (Hemiptera, Psylloidea) (Dalva Queiroz – EMBRAPA/Brazil and Daniel Burckhardt – Naturhistorisches Museum, Augustinergasse Basel, Switzerland)
3. A review of galls on ferns and lycophytes worldwide (Marcelo Guerra Santos – UERJ/Brazil
4. Cecidomyiidae (Diptera) of the Atlantic Forest (Valéria Maia – UFRJ/Brazil

(12:00h) Lunch time

14:00h – 16:00h
1. Multitrophic systems and defense against natural enemies (Uiara Rezende – UFU/Brazil)
2. Structural and chemical alterations in stem galls on *Eremanthus erithropappus* (Nina de Castro Jorge – UFMG/Brazil)
3. Galls induced in Al-hyperaccumulator plants (Ígor Arriola – UFMG/Brazil)
4. Gall development: how deep have we gone (Renê Carneiro – UFG/Brazil)

Day 3 – 17/ 11/ 2018 (09:00h)
Structural and functional profile of galls
10:00h – 12:00h
1. Gall abundance and distribution in tropical canopies is an evolutionary response to enemy free-space (Sérvio Pontes Ribeiro – UFOP/Brazil)
2. How to be a gall (Rosy Isaias – UFMG/Brazil)
3. Gall metabolism by anatomy and histochemistry: a new insights by old tools (Bruno Ferreira - UFRJ)
4. How the gall structure works: findings and perspectives (Denis Oliveira - UFU)

(12:00h) Lunch time

14:00h – 16:00h
1. Transcriptome profile in galls: whats up? (Vitor Martini – UFU/Brazil)
2. Structural convergence in bivalve-shaped galls induced Cecidomyiidae (Diptera) on *Mimosa gemmulata* (Fabaceae) (Elaine Cotrim – UFMG/Brazil
3. Prospection into anatomic, metabolic and genetic patterns in five morphotypes of galls in *Byrsomina coccolobifolia* Kunth (Malpighiaceae): a brigde between academic research and the formation of teachers (Reisila Mendes – UFMG/Brasil)
4. Dynamics of cell wall componentes during gall formation on Inga ingoides (Rich.) Wild. (Fabaceae: Cesalpinioideae) (Gracielle Bragança – UFMG/Brazil)

Poster presentation 16:00 as 17:30h

17:45h – Closing session

Symposium Biology of Galls

Brazil - 2018

ABSTRACTS

Organized by

Denis Coelho de Oliveira

Rosy Mary dos Santos Isaias

Symposium
Biology of Galls
Brazil - 2018

Functional ecology of gall traits – a lesson from aphids

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The intimate relationships between gall forming insects and their host plants attract much attention among botanists, entomologists, ecologists and evolutionary biologists. Gall induction has evolved convergently among and within various insect lineages indicating that the phenomena is highly adaptive. The mechanism of gall formation by insects is unknown but is seems that the insects do control gall induction and development for their own benefit. Using aphids (Hemiptera: Aphididae: Fordini) as model system we traced some key issues in the evolution of the gall formation while addressing the ecological force and the mechanisms involved. Our key findings (many are still waiting for answers) are: Gall type is closely associated with the aphid (not plant) species. The shift of these specialized aphids among closely related plant species is crucial for speciation. In this system, the ability of the aphids to manipulate the host plant to gain better nutrition may drive the evolution of gall divergence, shape and size. Aphid galls are well protected (in & out) against various natural enemies including pathogens, predators, parasitoides. Gall (aphids) defence is based on plant-derived secondary and primary metabolites. The chemical defence (at least of terpenoids) is 'self produce' in the galls following efficient manipulation of the plant machinery by the aphids. Host plant manipulation by the insect is manifested at the molecular level (gene expression), enzymatic activity, chemical accumulation and anatomical structure.

Key words: plant galls, aphids, functional ecology.

Parasitoids and inquilines of gall-inducing insects

Paul Hanson

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An overview is presented of the different types of parasitoids, with special emphasis on idiobionts (which cause permanent paralysis of the host) versus koinobionts (which do not), and the potential effects that each of these two types has on gall formation. Inquilines feed not on the gall-inducer, but rather on gall tissue, sometimes modifying the morphology of the gall. True inquilines feed almost exclusively on gall tissue; they may be non-lethal or lethal, and may or may not be taxonomically related to the host. Partial inquilines feed as both a parasitoid and an inquiline. A synopsis of the major hymenopteran families found in Neotropical galls is provided: Eupelmidae, Encyrtidae, Tanaostigmatidae, Torymidae, Eurtyomidae, Eulophidae, Pteromalidae, Platygastridae, Ceraphronidae, Ichneumonidae, and Braconidae. For each family a summary is given of the diagnostic characteristics, biology, and principal genera. Some parasitoids are found in a diversity of galls, for example Eupelmidae, *Torymus*, and *Chrysonotomyia*. Others are restricted to certain taxa of gall-inducers. For example, Encyrtidae are restricted to galls induced by Psylloidea, Coccoidea, or Lepidoptera, whereas Platygastridae are restricted to galls induced by Cecidomyiidae. The majority of parasitoids in galls are ectoparasitic idiobionts but a few, for example Platygastrideae, are endoparasitic koinobionts. There are methodological challenges involved in determining the biology (inducer, inquiline, or parasitoid) of each gall inhabitant, especially in galls where all the inhabitants are hymenopterans. In the case of Tetrastichinae (Eulophidae) this challenge is greatly increased by a lack of taxonomic study, whereas in *Allorhogas* (Braconidae) we can now predict in which galls these wasps are gall-inducers and in which galls they are parasitoids and/or inquilines. Tanaostigmatidae is probably the only group of Chalcidoidea that consists exclusively of gall-inducers and true inquilines, but more research is needed in order to accept or reject this hypothesis.
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Key words: plant gall diversity, parasitoids, natural enemies.

Natural history of gall-inducing psyllids (Hemiptera, Psylloidea).

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Gall-induction is relatively widespread among the 4000 described species of jumping plant-lice (Psylloidea), usually initiated by immatures but rarely also by oviposition or eggs. Most psyllid galls involve the leaf but galls are also known on the flowers, stems or roots. The morphology of psyllid galls is quite diverse ranging from crumpled leaves, leaf folds, open pits, tube or bivalve shaped structures to closed globose or lenticular bodies. Within the superfamily, some families have many cecidogenous species (Calophyidae, Phacopteronidae and, to a lesser extent, Triozidae), whereas others have hardly any (Carsidaridae, Homotomidae); the Aphalaridae, Liviidae and Psyllidae are, in this respect, intermediate. The most important host family is the Fabaceae which has surprisingly few psyllid galls whereas Sapindales and Myrtaceae bear many cecidogenous psyllids. In some cases (e.g. *Schinus*) one plant can host several psyllid species inducing different gall types (superhost). A problem in the study of psyllids galls is the literature which is plagued with misidentifications of the psyllids and of their hosts.

Key words: Hemiptera; Psylloidea; gall morphology; host plants; superhost.

A review of galls on ferns and lycophytes worldwide.

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Fern-insect interactions have not received the same attention as angiosperm-insect interactions have. It has even been stated that ferns may have very few interactions with animals because of their lack of flowers, fruits and seeds. Consequently, for many decades fern-insect interactions have been overlooked and underestimated, especially for highly developed interactions such as those with gall-formers. The present work aims to review the galls of ferns and lycophytes worldwide, to provide an updated check-list including unpublished data and to estimate of the global gall diversity of ferns and lycophytes. We recorded 93 host species, belonging to 41 genera. Galls were found in 20 fern families and one lycophyte family (Selaginellaceae). Most galls occur within the more derived ferns of the order Polypodiales, especially the fern families Polypodiaceae (21 host species), Dryopteridaceae (14 host species) and Athyriaceae (11 host species). Thirty-eight of the 133 gall morphotypes were induced by mites and 95 by insects of six orders (Coleoptera, Diptera, Hymenoptera, Lepidoptera, Thysanoptera, and Hemiptera). Among the insects, Cecidomyiidae (Diptera) caused most of the galls (35 morphotypes). So far, most galls have been reported from the Neotropical region (40 spp.) and Oriental region (28 spp.). (FAPERJ, CNPQ, PROCIENCIA-UERJ)

Key words: Cecidomyiidae; fern-insect interactions; herbivory, mites; pteridophytes

Cecidomyiidae (Diptera) of the Atlantic Forest

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Cecidomyiidae are the most important group of gall-inducing insects and one of the most diverse families of Diptera. About 600 species have been recorded in the Neotropical Region, 225 in Brazil. The Atlantic Forest is a typical biome from Brazilian coast with a great biodiversity and high index of endemism. The main objective of this study is to establish the number of species of Cecidomyiidae of the Atlantic Forest, to know the richness of species in the different physiognomies of this biome, to point out the most diverse genera and to indicate endemic species based on plant endemism. Data were retrieved from the catalog of Cecidomyiidae of the world (Gagné & Jaschhof, 2017) and from the taxonomic papers published after this date. The plant names were updated and data on plant endemisms were obtained from the site "Flora do Brasil". Biomes were established based on localities. As result, a total of 168 gall midge species was counted. Most species were collected in Restinga (63%) and Dense Ombrophilous Forest (34%). The most diverse genera were *Asphondylia*, *Lopesia*, *Bruggmannia*, *Clinodiplosis*, and *Dasineura*. 34 species of Cecidomyiidae are endemic in Brazil, 23 being endemic in the Atlantic Forest. There are about 1,400 galls induced by Cecidomyiidae in inventories of the Atlantic Forest, indicating that only 12% of the species of this biome are known.(CNPq)

Key words: diversity, endemism, gall midges; Neotropics.

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Multiple gall traits and galling survival in a multi-enemy context

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Galls induced by *Palaeomystella oligophaga* (Lepidoptera) on *Macairea radula* (Melastomataceae) are conspicuous structures with varied traits. Regardless of that, several types of insects attack the galling. Using this system as model, considering the enemy hypothesis and the selection of secondary characteristics, we aimed to respond which gall traits influence galling survival success, considering and describing all the different enemy kinds present in the community. Galls was collected after measured height on host plant, then were analyzed for color variation, trichomes length and parenchyma thickness. Despite the structural complexity of these galls, the studied gallings were attacked by a diversity of organisms, totalizing 78,8% of enemy occurrence and therefore galling mortality. Parenchyma thickness was negative related with the *Caliephialtes* sp. parasitoids, lepdoptera cecidophages and predation. On the other hand, the occurrence of lepdoptera cecidophages and predation as well as *Bracon* sp. parasitoids were positive related with the heights of gall on plants. Gall color and size of projections did not relate with the presence of any galling enemy. Total indirect attack caused 47,3% of mortality, against 31,5% of those three groups that consumed the galling directly. *P. oligophaga* have many enemies that explore them and gall structures as resources, causing massive top-down regulation. Especially, those indirectly enemies presented a greater threat to the population rates of galling survival than the directly ones. In this sense, whatever trait effective against whichever enemy may have positive population effects, especially over the generations.

Keywords: cecidophages, indirectly enemies, gall aposematism, multitrophic, enemy hipothesis

Eremanthus erythropappus senescent globoid stem galls and ants

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Eremanthus erythropappus (DC.) McLeisch (Asteraceae) is a super-host plant of six gall morphotypes. It is common to find galls, induced by *Neolasioptera* sp. (Diptera: Cecidomyiidae) in the stems of this plant species. We analyzed gall structure in an attempt to (i) characterize the structural alterations of the young and senescent galls aiming to evaluate how the gall-inducing insect change the structural profile of the host-plant organ, (ii) evaluate senescent galls occupied by ants, in order to determine if there is a preference of the ants for the largest or to the smallest galls, (iii) characterize the ant occupants of galls in order to determine if ants form nests and colonies inside the galls, and (iv) characterize the chemical profiles of young and senescent galls in order to determine if there are any chemical compounds that could signalize for ants. The process of gall senescence starts with the exit of the inducer through an exit or escape channel, and afterwards senescent galls can be occupied by ants. Six different ant genera at various life stages were found inside the galls, suggesting that the galls are used as nests. The chemical analyzes showed variations between the samples of young and senescent galls.

(FAPEMIG, CNPQ, CAPES)

Key words: Ants, Globoid galls, Senescence, Structural alterations.

Galls induced in Al-hyperaccumulator plants.

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In Brazilian *cerrado*, some *tax*a of host plants of galling herbivores, such as the Melastomataceae, accumulate large amounts of aluminum in their tissues. Aluminum accumulation has many negative effects on plants, including the inhibition of cell division and growth in meristematic regions. *Ditylenchus gallaeformans* (Tylenchida: Anguinidae) is a phytonematode, which induces galls on leaves and inflorescences of several species of *Miconia* and *Leandra* (Melastomataceae). These galls have indeterminate growth by the promeristematic capacity of nutritive cells as its remarkable characteristic. We tested the aluminum presence in these galls induced in *Miconia corallina* and *Leandra lacunosa* by some Al-specific stains, and we expect that aluminum should concentrate in tissues far from the nutritive (promeristematic) regions of the galls. Aluminum concentration sites differ between non-galled leaves and galls, and contradicts the scenario that we expected. In addition, aluminum does not seem to affect the promeristematic capacity of these galls. (FAPEMIG, CAPES)

Key words: Aluminum, Melastomataceae, morin, promeristematic cells

Gall development: how deep have we gone?

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Gall development has long been the focus of many researches around the world. Recently, the study of gall development has shifted from the classical anatomical approach towards the comprehension of cellular mechanisms for the redifferentiation of new cell types with new functions. Currently, neotropical galls are studied on the basis of anatomy, cytology, histochemistry and immunocytochemistry. So far, galls induced by insects, mites and nematodes in an array of different host plants show remarkable complexity and uniqueness, as far as their cell biology is concerned. Nutritive cells and tissues have been recorded in galls formerly considered non-nutritive, together with unprecedented cellular gradients of nutritive compounds and related enzymatic metabolism. Cytological findings show subcellular mechanisms by which cells subjected to high oxidative stress avoid damage by developing plastoglobuli inside plastids and multivesicular bodies in the cytoplasm or associated to plasma membrane. The cell wall composition in different tissue compartments is potentially the most variable subcellular characteristic of galls. Profiles of pectin, proteins and hemicelluloses affect cell wall properties such as flexibility and porosity, which shed lights into gall structure and metabolism, by clarifying cell wall extensibility the transit of molecules between neighboring cells, respectively. Such dynamic composition may even relate to developmental processes such as the maintenance of cell juvenility or the occurrence of programmed cell death along the gall cycle. The diversification of approaches to the studies of gall development enriches the perception of gall formation, especially regarding the mechanisms behind the determination of new cell phenotypes. (CNPQ, CAPES)

Key words: cell walls immunocytochemistry, metabolic gradients, ontogenesis, ultrastructure

Gall abundance and distribution in tropical canopies is an evolutionary response to enemy free-space

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Gall-forming insects reach highest diversity, abundance and survivorship on sclerophyllous vegetation. This pattern was recently reviewed and shown as a habitat rather than ecosystem effect. We tested the hypothesis that upper forest canopies are probably the best suitable habitat for gall-forming insects in any tropical vegetation, comparing the wet rainforest of Panama (Neotropical), and the subtropical forest of Australia (Australian). We further tested whether foliage/plant community traits could influence this gall distribution pattern, and weinvestigated the effect of host family size and evolutionary age. Foliage traits, leaf chewing herbivory, and gall abundance and survivorship were measured using vertical cylindric transects from the understorey to the canopy. In both Panama and Australia, leaf sclerophylly increased significantly with sampling height, while free-feeding herbivory decreased inversely. Gall distribution and survivorship responded significantly to sclerophylly, but distribution between understorey and canopy varied between study sites. The probability of gall survivorship increased with increasing leaf sclerophylly as death by fungi, parasitoids or accidental chewing were greater in the non-sclerophyllous vegetation in the understorey of both study sites. However, number of galls, proportion of infected sampled plants, and proportion of host species against total sampled species were all greater in Panamá than in Australia. On the other hand, the Australian forest had a fauna much more concentrated on fewer hosts, with 80% of galls infesting six host species. The present study supports the existence of a global positive effect of sclerophylly on gall establishment and survivorship in the upper canopy of tropical and subtropical forests.

How to be a gall

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Janzen, in 1979, published a revision text entitled “How to be a fig”, where the intriguing fig flowers, fig fruits and fig wasps were featured. That text inspired me into presenting: "How to be a gall". Figs and galls have some features in common; both represent plant-insect interactions, insects complete their life cycles inside them, thus being dependent on the association with their host plant organs to survive. Many organisms are capable of inducing galls, but insect, mite and nematode galls have been the focus of many studies in the neotropics. Each organism involved in the host plant-animal interaction may influence the evolution of the other, and the survivorship of both demands refined structural and physiological supports. Galls have a variety of colors and shapes; which among other features served as the basis of our proposal for standardization of a morphological nomenclature of galls, the "Illustrated and annotated checklist of Brazilian gall morphotypes". Gall morphotypes are constituted of specialized cells, and configure elegant models of study for researchers interested in cell biology, biochemistry, developmental anatomy, physiology, ecology, and genetics. Galling organisms come into contact with plant tissues mostly by their mouthparts, and plant cells immediately react by producing metabolites that may trigger programmed cell death (PCD), and lead to cell sacrifice toward saving the organ, a hypersensitive reaction. However, gall establishment and success depends on two-way signaling molecules, which orchestrate refined processes toward keeping the homeostasis. The homeostasis is conquered by a microenvironment full of primary and secondary metabolites, which turn galls both vulnerable and attractive to a guild of parasitoids, predators, and inquilines. The entrance of such organisms in the gall structure may interfere in gall physiology, and may sooner or later, kill the gall inducer. Due to the death of the galling organism, or to its escape from inside the gall, plant cell and tissue metabolism is redirected to senescence, when energy resources and nutrients may be remobilized towards non-galled plant tissues. Nevertheless, phenomena, such as "green islands" and gall colonization by fungi and ants after the galling organism escape from the gall may indicate that the web of parallel interactions and physiological signaling by the end of its gall life cycle is yet to be explored. Parallel interpretations on the biology of insect galls and the biology of nematoda galls have challenged us on a new set of cell responses and abilities that keep or return cells to their meristematic condition, which can be explored both in plant cell biology and molecular perspectives.

Gall metabolism by anatomy and histochemistry: new insights by old tools

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Histochemical localization is a way of detecting the sites of primary and secondary metabolites accumulation, and also the activity of determined enzymes in particular tissues or cell types. As the galls are product of changes in cell differentiation processes, studies that integrate plant anatomy, physiology and histochemistry indicate how metabolic alterations dictate changes in cell hypertrophy, hyperplasia, differentiation of storage cells, and even the maintenance of a meristematic activity. Nematode, insect and mite galls have distinct processes of growth and development, and the alterations in gene expression, plant signaling, enzyme activity and cell development are constant and well guided, since galls induced by a specific galling species on a specific host plant have the constant histological and physiological features. Histochemical profiles indicate a greater accumulation of energetic metabolites such as reducing sugars, lipids and proteins in nutritive tissues (NT), the group of cells involving the gall inducers inside the galls. Cytokinins in NT are related with hyperplasic processes, and energetic metabolites are important for the maintenance of cell division rates, and for the nutrition of gall inducers. Cytokinins establish stronger sinks of photoassimilates in gall inner tissue compartments by up-regulating the activity of invertases, which break sucrose provenient from gall outer tissue layers. In some galls, at the transition region between outer tissue layers and NT, phosphorylase may be acting by the degradation of starch into sucrose. Using histochemistry, we are able to indicate how the galls function, and by which metabolic changes the cells redirect their differentiation. Important cues on how the galling animals can manipulate cell differentiation in plants, as well as by which type of signaling, and by controlling the expression of certain genes may be obtained. Studying galls makes us looking forward to finding the determiners of plant cell differentiation, from the molecular to the anatomical points of view, and that’s why it is so fascinating. (CNPq, FAPEMIG)

Key words: histochemistry; enzyme activity; carbohydrate metabolism; plant hormones; nutritive tissue.

How the gall structure works: findings and perspectives

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The interaction between galling insects and host plant is commonly species-specific, resulting in a large diversity of gall morphotypes. Depending on the galling taxa and feeding behavior the gall structure can have different and characteristic forms, such as projection, trichomes, bizarre shapes and conspicuous colours. The key processes of gall development to get a specific form are assessed using especially histological and histochemical tools. Here, I'd like to discuss how the gall structure works, especially measuring photosynthesis on both green and red-green galls. In addition, we looking to evaluate whether the galling insect induce a true oxidative stress in the gall tissues. Because of high oxidative stress in galls, detected especially using histochemical techniques and MDA (malondialdehyde), the photosynthetic activity can be damaged both in gall site and in the non-galled tissues around the gall. The chlorophyll *a* fluorescence represents a tool for oxidative stress detection in plants and can be used to evaluate stress in gall tissues. In general, we found low values of maximum quantum efficiency of PSII (F_v/F_m) and maximum PSII operating system $[(F'_m - F')/F'_m]$, indicating a decrease in photosynthetic performance in galls. We can also find the decrease of tissue vitality in galls. Photosynthesis in galls can be discussed on two main perspectives: (i) avoiding hypoxia and hypercarbia in the highly compact gall tissues and (ii) maintenance of tissue homeostasis and oxidative stress control. Some galls are exposed to higher incident light and consequently accumulates anthocyanins. This pigment accumulation in galls function as a photoprotective strategy, maintaining the tissue vitality and photosynthetic activity, as well helping in the oxidative stress scavenging. (FAPEMIG, CNPQ, CAPES)

Key words: Chlorophyll *a* fluorescence; photosynthetic pigments; protein storage; reactive oxygen species; tissue gradients.

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Structural convergence in bivalve-shaped galls induced by Cecidomyiidae (Diptera) on *Mimosa gemmulata* (Fabaceae)

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We surveyed if the three bivalve-shaped galls induced by Cecidomyiidae on *Mimosa gemmulata* may have convergent structural responses imposed by the constraints of the host plant. So, the following questions were addressed: (1) can the host plant impose constraints, resulting in convergent responses in the origin and destinations of the bivalve-shaped gall tissues? (2) Can compartmentalization of the gall tissues be convergent in the bivalve-shaped galls? The three bivalve-shaped galls are induced in the adaxial surface of the young pinna-rachis. The dermal tissue system and the nutritive tissue are originated from the dermal system of the pinna-rachis. The vascular and ground systems in the galls are originated from the vascular and ground systems of the pinna-rachis. In mature stage, gall tissues are differentiated and compartmentalized. The outer tissue compartment is formed by epidermis, vascular and ground system, while the inner tissue compartment is constituted by the nutritive cells. There is a variation in the number of layers in the tissues among the bivalve-shaped galls. The origin, tissue destinations, and compartmentalization in the three bivalve-shaped galls are convergent responses imposed by the constraints imposed by site of induction, the pinna-rachis. However, the structural pattern in the outer and inner tissue compartments is variable, constituting divergent responses imposed by the different species of Cecidomyiidae. (FAPEMIG, CNPQ, CAPES)

Key words: compartmentalization of the tissues; destination of the tissues; host plant constraints; origin of the tissues.

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Dynamics of cell wall components during gall formation on *Inga ingoides* (Rich.) Willd. (Fabaceae: Caesalpinioideae)

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During gall formation, processes such as hyperplasia, hypertrophy, and cellular re-differentiation are common and essential for generating new tissues and new morphotypes. Herbivorous insects redirect the accumulation of auxins, phenolics and reactive oxygen species to gall developmental site, which may favor the flexibility of the cell wall toward hypertrophy. Cell wall flexibility may be related to the dynamics of cell wall components, such as cellulose microfibrils and hemicelluloses. Hemicelluloses unite cellulose microfibrils and are crucial for regulating growth, resistance, and the remodeling of cell walls. The loosening of glycosidic and hydrogen bonds between microfibrils and hemicelluloses can promote the reorientation of cellulose microfibrils and changes in the axes of cell expansion during the formation of different morphotypes. We investigated the interaction of phenolics, auxins and reactive oxygen species, and the dynamics of cellulose microfibrils, with hemicelluloses during the development of three gall morphotypes in *Inga ingoides* (Fabaceae). We expected the dynamics of hemicelluloses and microfibrils to be related to the age of the galls. However, we observed that the presence or absence of hemicelluloses during the development of the galls was peculiar to each morphotype and the dynamics in cell wall can be associated to variations in the axis of cell expansion and to the site of gall induction (CAPES, FAPEMIG e CNPq).

Key words: Cell wall, cellulose microfibrils, galls, hemicelluloses.

Metabolic and cytological compartmentalization in galls on *Inga ingoides* (Rich.) Willd. (Fabaceae: Caeselpinoidae)

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Galls are plant structures formed by the induction of virus, acari, bacteria, nematodes and insects. During its development, plant tissues are restructured, generating anatomical, histochemical and cytological compartmentalization. This compartmentalization may be subjected to constraints imposed by the host plant, and convergent responses can be observed in different morphotypes induced in the same plant. The present study analyzes the anatomical, cytological and histochemical profiles of three gall morphotypes associated to *Inga ingoides* with the objective of verifying the compartmentalization pattern in different morphotypes. The galling herbivores altered the metabolism of the leaflets of *I. ingoides*, inducing the differentiation of two distinct tissue compartments in the three gall morphotypes. Histochemical analyzes demonstrated that accumulation of metabolites is a similar feature shared by all gall compartments, directed to defense against parasitoids in the outer tissue compartment and to nutrition of the gall inducer in the inner tissue compartment. However, cytological analyzes reinforced divergent characteristics in each system, evidencing the extended phenotype of each galling insect and a variety of solutions for convergent functionalities (CAPES, FAPEMIG e CNPq).

Key words: Compartmentalization, hitochemical, cytology

Description of three new species of *Bruggmanniella* Tavares, 1909 (Diptera, Cecidomyiidae) from Brazil and a key for species.

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Bruggmanniella Tavares, 1909 included 11 species, distributed geographically in Nearctic (n=1), Neotropical (n=8), and Oriental (n=2) regions. The genus is characterized by having adults with three-segmented palpus, simple tarsal claws, female segment 8 with cerci-like lobes and male with a completely divided tooth of gonostylus; pupa with apices of antennal bases projected, lack of frontal horns and presence of dorsal abdominal spines; larva with four-toothed spatula. Three new galling species from Brazil were obtained from stem of *Miconia theizans* (Bonpl.) Cogn (Melastomataceae) collected in Dores do Indaiá city, Minas Gerais, and fruits of *Ocotea notata* (Nees and Mart.) Mez (Lauraceae) and of *Sideroxylon obtusifolium* (Roem. and Schult.) T. D. Penn. (Sapotaceae) collected in Mangaratiba city, Rio de Janeiro. *Bruggmanniella* sp. nov. 1 presents palpus one-segmented, hypoproct deeply bilobed, ovipositor rigid portion 1.6-1.9 length of sternite 7, antennal bases projected 0.23-0.26 mm long with micro serrated margin, apical plate and prothoracic integument with short spines. *Bruggmanniella* sp. nov. 2 has hypoproct sligthly bilobed, ovipositor rigid portion 3.1 length of sternite 7, antennal bases projected 0.11-0.18 mm long with micro serrated margin, apical plate integument smooth and prothoracic integument rough. *Bruggmanniella* sp. nov. 3 presents flagellomeres with striated short necks, hypoproct deeply bilobed, ovipositor rigid portion 2.2-3.0 length of sternite 7, antennal bases projected 0.21-0.26 mm long with micro serrated margin, apical plate and prothoracic integument rough. An illustrated key to the *Bruggmanniella* species is elaborated, with informations of male, female, pupa, larva, gall and host plant. (CNPQ)

Key words: Cerrado; gall midges; Neotropics; restinga; taxonomy.

REPRESENTATIVENESS OF THE GENUS *CONTARINIA* (INSECTA, DIPTERA, CECIDOMYIIDAE) IN THE ENTOMOLOGY COLLECTION OF THE NATIONAL MUSEUM / UFRJ

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Contarinia Rondani, 1860 (Diptera, Cecidomyiidae) is a widely distributed genus comprising 301 described species, although only six occur in the Neotropical Region, two of which have been recorded in Brazil. *Contarinia* includes galling, gall inquilinous and free-living phyytogophagous species. A total of 63 plant families have been associated with this gall midge, but it is most frequent on species of the families Fabaceae, Asteraceae, Poaceae and Rosaceae. In order to assess the richness and geographic distribution of Contarinia in Brazil and to elaborate a list of host plants, we compiled data from the literature and the Cecidomyiidae collection of Museu Nacional-Universidade Federal do Rio de Janeiro (MNRJ). Contarinia is represented by two species in Brazil, *Contarinia gemmae*, Maia, 2003a and *Contarinia ubiquita* Gagné, 2001,and by 34 morphospecies (14 retrieved from MNRJ, five from the literature and 15 from MNRJ and the literature). Based on data from the MNRJ, ten plant species and two plant genera are added as host plants of *Contarinia*, and its geographic distribution is extended to eight localities in Brazil. The genus occurs in four phytogeographic domains — Atlantic Forest, Cerrado, Amazonian Forest, and Pantanal — but has its greatest richness in the Atlantic Forest (62.6% of the records) followed by the Cerrado (32.5%), the two most investigated domains. These data reflect the amount of available information and not necessarily the true distribution of Contarinia in Brazil

.**Key words:** Geographical distribution, *Contarinia* and Host plants

New geographical records of species of Clinodiplosis (Diptera, Cecidomyiidae)

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Clinodiplosis Kieffer, 1895 is a genus with 107 species and broad geographical distribution. In Brazil, 19 gall-inducing species are recorded, 10 known only from the locality-type: *Clinodiplosis chlorophorae* Rubsaamen, 1905, *C. marcetiae* Tavares, 1917, *C. rubiae* Tavares, 1918, *C. melissae* Maia, 1994, *C. diodiae* Maia, 2001 in RJ, *C. pulchra* Tavares, 1917 and *C. bahiensis* Tavares, 1917 BA, *C. agerati* Maia, 2016 MG, *C. cearensis* Tavares, 1917 PE, *C. iheringi* Tavares, 1925 SC. *Clinodiplosis profusa* Maia, 2001, *C. costai* Maia, 2005, *C. conica* Oliveira & Maia, 2008, *C. floricola* Novo-Guedes & Maia, 2008 and *C. maricaensis* Maia, 2011 occur in RJ, *C. eupatorii* Felt, 1911 PA, Costa Rica and Trinidad, *C. bellum* Urso-Guimaraes & Carmo-Neto, 2015 SP, *C. alternantherae Gagné*, 2004 RS, SC, BA, Argentina and Uruguay, and *C. cattleyae* Felt, 1908 Brazil (not informed locality), Mexico, Ecuador, Jamaica, Hawaii (USA) and western Europe. The present work expands the geographic knowledge of the species of this genus. Data were obtained from catalogs and exsiccates of the Herbarium of the Botanical Garden of Rio de Janeiro (RB). A total of 1,318 plants were examined. The geographic distribution of four species was expanded: *Clinodiplosis chlorophorae* for the northeast region (BA) and MG, *C. alternantherae* for the southeast region (SP), *C. bellum* for the north (RO), northeast (PI) midwest (GO, MT, MS), and *C. agerati* (RJ) for RJ. Data on the distribution of the genus in Brazil are still very scarce, demonstrating the need for surveys, essential for future phylogenetic and biogeographical studies.

Key words: galls, host plant, geographic distribution

Agromyzidae (Insecta: Diptera) galls from Brazil: What is known?

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Galls of Agromyzidae (Diptera) are found in different host plants, such as Anacardiaceae, Asteraceae, Fabaceae and others. The galls usually occur on leaves, but also on stems, buds and fruits. About 40 species of gall-inducing agromyzids are known, being distributed in seven genera: *Agromyza* Fallen, *Japanagromyza* Sasakawa, *Hexomyza* Enderlein (exclusively galling), *Melanagromyza* Hendel, *Ophiomyia* Braschnikov, *Phytoliriomyza* Hendel, and *Phytomyza* Fallén. We aimed to investigate the knowledge of gall-inducing Agromyzidae in Brazil. *Agromyza terebrans* Bezzi & Tavares, described in 1916, was the first galler described for Brazil, inducing galls on leaves of Papilionaceae. Later, this inducer was recorded in association with *Clitoria cajanifolia* (C. Presl) Benth. (Fabaceae). Recently, *Japanagromyza inferna* Spencer was found by the authors in restinga areas of São João da Barra, Arraial do Cabo, Saquarema and Marambaia (Southeast Region, Brazil). The species induces globoid galls on leaves of *Centrosema virginianum* L. (Fabaceae). Adults were obtained by rearing. Their emergence was observed in January, February, June and November. The specie was redescribed based on this material. Agromyzid galls in Brazil are little known, probably due to the lack of studies, resulting in only one species recorded in recent years, after more than a century, since the first record. Exploratory initiatives are needed to increase the knowledge of galls of Agromyzidae and their host plants. (CNPQ).

Key words: Agromyzids; insect-plant interactions; gall-inducing.

Does the galling Cecidomyiidae stimulate the formation of histochemical gradients in tissue compartments of the bivalve-shaped gall?

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We investigated the formation of the histochemical gradients in the tissues of the bivalve-shaped gall induced by a Cecidomyiidae (Diptera) on *Mimosa gemmulata* (Fabaceae). Mature galls have compartmentalized tissues, and histochemical gradients are formed within these tissue compartments. Reducing sugars and proteins accumulate in a centripetal gradient toward the inner tissue compartment. Phenolic compounds, flavonoids, terpenoids, and lipids accumulate in a centrifugal gradient toward the outer tissue compartment. Histochemical gradients are associated to the adaptive value of the galls for the galling insects. The histochemical gradients of the secondary metabolites in the bivalve-shaped promote defense against natural enemies and oxidative stress, while primary metabolites are related to the nutrition of the galling Cecidomyiidae, and to the structural maintenance of the bivalve-shaped gall. (FAPEMIG, CNPQ, CAPES)

Key words: compartmentalization of the tissues; defense; galling-Cecidomyiidae nutrition; primary metabolites; secondary metabolites.

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Prospection into anatomic, metabolic and genetic patterns in five morphotypes of galls in *Byrsonima coccolobifolia* Kunth (Malpighiaceae): a bridge between academic research and the formation of teachers

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We propose the construction of four educational devices, involving topics related to undergraduate students of Biological Sciences. Such proposal aims to o getting the knowledge produced by scientific research to the future teachers of basic education. The first device is based on citizen science principles, and will generate larger amounts of data with the conscious and voluntary participation of citizens. We will develop an application for Android and IOS with students of Biological Sciences of the Universidade Estadual de Minas Gerais. The 'citizen-scientists' will contribute to the research by taking photographs of galls and their host plants, with georeferenced location, date and time. The second device is the Botanical journal, a daily log record of our contact with plants to raise the awareness about the role and importance of plants in our daily life, and the conservation of life on planet Earth. The third device will be an notebook with morphological and anatomical data produced with *Byrsonima coccolobifolia* as a model plant. This model will base the creation and insertion of similar data about UEMG Ibirité forest plants by the 'citizen scientists'. Histological slides produced with the forest plants will be incorporated into interactive activities used in face-to-face teaching or Distance Learning (EaD). This experience can be repeated with school, garden, or any green areas that the basic scholl teacher may choose with his/her students. The fourth device will be an interpretive and autoguided trail addressing historical, ecological and social aspects of the a natural site. During the trekking, the group will be invited to explore and understand the forest on the basis of six interpretative points marked in a guide - the Botanical Notebook - which will be provided at the beginning of the walk. We expect to stimulate the study of Botany and Plant-Insect interaction and the respect for nature.

Key words: education device; formation of teachers;scientific research