Alkaline-acid intestine environment controlled by a carbonic anhydrase gene influences synthesis of sex pheromone by symbionts

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Abstract: The intricate interplay between animals and their intestinal microbes is pivotal in shaping various aspects of animal biology. However, the degree to which hosts can modulate the activity of their intestinal microbes, as well as the underlying molecular mechanisms, remains poorly elucidated. Here we showed that the production of sex pheromones by rectal Bacillus in male Bactrocera dorsalis was triggered by the alkaline intestine environment. An experimental increase in pH led to more sex pheromone production, or vice versa. pH modulated the synthesis quantity of sex pheromone by exerting an impact on the activity of enzyme synthesizing sex pheromone inBacillus. Transcriptome analysis showed that a highly expressed carbonic anhydrase (CAh) gene in B. dorsalis was associated with alkaline rectal environment. CAh inhibitor feeding and RNAi targeting the CAh gene led to a shift from alkaline to acidic conditions within rectum and subsequent decreasing in sex pheromone synthesis and mating. This study provides novel insight into the influence of intestinal environment on intestinal microbes and has significant implication for understanding the molecular mechanism underlying sex pheromone synthesis by symbionts ininsects.

Hot Breath, Quick Exit: Aphids Flee Mammalian Heat via TRPA1

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Abstract: Animals have developed scent-triggered avoidance for threat evasion and survival. Here, we found that aphids exhibit a unique heat-guided herbivore-avoidance mechanism. We identified the TRP channel ApisTRPA1 in Acyrthosiphon pisum as a key receptor for sensing rapid temperature increases. Two isoforms of ApisTRPA1, ApisTRPA1-A and ApisTRPA1-B, are both expressed in neurons located in the primary rhinaria, which are essential for acute heat detection. Among them, ApisTRPA1-B exhibits a stronger response to temperature gradients. Furthermore, we found that ApisTRPA1 is a multimodal receptor and acts as a chemosensor activated by natural plant compounds. These findings shed light on aphid physiological adaptations to thermal cues and may inform the development of eco-friendly aphid management strategies.

Keywords: Acyrthosiphon pisum; pre-encounter escape behavior; transient receptor potential A1; thermosensitive neuron; thermal sense; heat avoidance

Jack and beanstalk: Tissue-specific response in plant-insect interaction

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Abstract: Plants have evolved sophisticated strategies for regulating their ecological interactions with insects. Although extensive researches have deeply elucidated the phenomena and underlying mechanisms of these interactions at the population and individual levels of plants, knowledge regarding how plants interact with insects at the tissue level remains limited. Similar to Jack ascending the giant beanstalk, facing challenges, and securing rewards in the tale of Jack and the Beanstalk, insects navigating large plants encounter distinct risks and rewards across different tissues. Our researches on Solanaceae plants reveal evidence suggesting that plants can generate tissue-specific defense signals, driving tissue-specific synthesis or release profiles of primary and secondary metabolites, which subsequently modulate insect behavior and performance in a tissue-specific manner. Notably, certain metabolites in these tissue-specific interactions not only exhibit diversified regulatory patterns in their synthesis but also demonstrate functional versatility in modulating the behavior of different target insects, reflecting the significance of ecological pleiotropy in plant metabolites during proximal plant-insect interactions.

Tread different paths that lead to the same destination: a symbolic info-chemical (EBF) perception by both aphid Sitobion avenae and its parasitoid Aphidius gifuensis

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Abstract: In natural settings, the parasitism rate of Aphidius typically ranges from 20% to 60%, which plays a crucial role in controlling aphid outbreaks. Artificial release can overcome the lag effect of parasitoid wasps, achieving a more pronounced suppression of aphid population development. Over the past decade, we have focused on deciphering the chemical communication between wheat aphids and their dominant parasitoid, Aphidius gifuensis, in an effort to identify key compounds that can help the released parasitoids locate target fields, reside there, and continue to exert control effects in the open ecosystems. This ultimately aims to reduce the release amount of parasitoids, will lower the release cost, and achieve biological control of wheat aphids in crops with low economic added value, such as wheat fields. (E) -β-farnesene (EBF) is the alarm pheromone in aphids and an allomone for their natural enemies, which can locate and identify the aphids emitting this signal. This work reports the study conducted on the chemical communication between wheat aphids and their natural enemies. It reveals that the peripheral signal transduction process of EBF recognition in wheat aphid Sitobion avneae involves odorant-binding proteins (OBP3/7/9) and odorant receptors (OR5+ORco). And in its parasitoids A. gifuensis involves OBPs (OBP6 and OBP9), and the OR is still in progress. In light of the research progress here as well as on other aphid species and their predatory natural enemies, we propose that aphids and their natural enemies, starting from different evolutionary origins, have undergone a clear case of convergent evolution in their olfactory functional proteins at various levels (OBP, OR) towards the recognition of (E)-β-farnesene (EBF). More importantly, we proved that A. gifuensis can integrate olfactory and tactile senses to identify EBF at as low as nanogram level, far exceeding the detection threshold of aphids. A low concentration of EBF, which does not alert the aphids already colonized and causing damage, can provide clues for A. gifuensis to target and significantly enhance its biological control efficacy. This finding has opened up new possibilities for the application of EBF in the field of biological control from a novel perspective.

Keywords: alarm pheromone;aphid;Aphidius

Tool use aids prey-fishing in a specialist predator of stingless bees

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Abstract: Tool use is widely reported across a broad range of the animal kingdom, yet comprehensive empirical tests of its function and evolutionary drivers remain scarce, predominantly focused on a few relatively intelligent vertebrate lineages. In this study, we provide a comprehensive examination of tool use behavior in the assassin bug *Pahabengkakia piliceps*, a specialist predator of stingless bees that exploits resin droplet from bee nest entrance to facilitate hunting. Field behavioral experiments demonstrated that resin use is critical for hunting success, as the predator uses resin to stimulate the colonial defense of stingless bees, luring attacking bees toward its optimal hunting position. Chemical analysis revealed that resin processing by the assassin bug enhances the emission of volatile compounds, making the resin more attractive and stimulating to guard bees. Through these experiments, we empirically demonstrate how an invertebrate predator adapts to the colony defense of social insects via tool use behavior. We further propose that complex tool use can evolve under selective pressures driven by diet specialization. Our findings offer a new model for studying the adaptive functions and underlying mechanisms of tool use behaviors in animals.
Keywords: tool use; invertebrate; predation efficiency; social bee; assassin bug

Behavioral Adaptation of Oriental Armyworm to Host Plant Defense

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Abstract: Female insects oviposit in sites suitable for the development of their offspring. The Oriental armyworm, *Mythimna separata* is a serious pest of various crops including wheat and prefers to oviposit on withered leaves rather than on fresh plant material, which is surprisingly different from other insects. Our studies showed that this oviposition tactic enables avoidance of wheat defence against eggs and emerged larvae. Intact plants responded to *M. separata* egg deposition by releasing oviposition-induced plant volatiles including acetophenone, tetradecene and pentadecane. Acetophenone was identified as quantitatively accounting for the attraction of the egg parasitoid wasp *Trichogramma chilonis*. Leaf jasmonic acid levels significantly increased after *M. separata* laid eggs, and primed the plant against emerging larvae. In addition, newly emerged *M. separata* larvae adopted a fast crawling behaviour and starvation tolerance, which enhanced the value of oviposition on the withered leaves compared with other noctuid insects. The elucidation of this complex and surprising plant-insect interaction provides the first explanation for a herbivore laying eggs on withered leaves in order to avoid natural enemies and live-plant defence against emerging larvae.

Carbon dioxide drives oviposition in Helicoverpa armigera

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Abstract: As a vital constituent of the atmosphere, carbon dioxide (CO2) holds a pivotal position in maintaining life on earth. CO2 is also a powerful greenhouse gas, which have risen dramatically over the past century, leading to widespread ecological effects on plants and animals alike, including insects that serve vital roles in many food webs. Elevated atmospheric CO2 is anticipated to affect insect biodiversity by influencing essential behaviors, although the mechanisms remain poorly understood. Here, we demonstrate that female Helicoverpa armigera use plant-emitted CO2 as a primary cue for egg-laying, showing a preference for younger leaves with higher CO2 gradients to enhance offspring survival. Elevated environmental CO2 disrupts this preference, reducing females' attraction to optimal egg-laying sites. Employing genome editing tools, we assessed the CO2 receptors in this species and proved three gustatory receptors—HarmGR1, HarmGR2, and HarmGR3—that form a trimeric complex in the sensory neurons of the labial palp organ, essential for CO_2 detection. These neurons project to the labial pit organ glomerulus (LPOG) in the antennal lobe, which mediates CO2-responsive behavior. Genetic disruption of any of these receptors impairs CO2 sensing and alters oviposition behavior. Our findings underscore the essential role of CO2 in moth reproductive behavior and reveal that rising anthropogenic CO2 levels may have significant ecological and agricultural repercussions.
Keywords: carbon dioxide;Helicoverpa armigera;oviposition;CO2 receptor

Plant volatiles and food availability mediate insect phenological migrations

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Abstract: Plant volatiles are the principal cues in orchestrating insect community across terrestrial ecosystems. However, little is known about how plant volatiles meditate insect phenological distributions. Here, we found that woody perennials hosted a dynamic amount of the bean bug Riptortus pedestris, peaking from late autumn to early spring, indicating that they served as hibernacula of R. pedestris. Adult R. pedestris largely migrated to flowering faba beans and peas in early spring, moved to soybeans in summer, and back to hibernacula in late autumn. Phenological studies indicated that the pest mainly had three generations per year. Adults of overwintered, first and third (i.e., overwintering) generations appeared to contribute to the three migration peaks, respectively, whereas adults of the second generation mainly remained feeding and reproducing on hosts (e.g., soybeans) without significant migrations. Laboratory tests found that the flight capability was negatively related to food availability, in line with extremely low proportions of adults of the second generation caught by odor traps while feeding on soybeans in the field. Therefore, migrations between sites of feeding and dormancy were probably triggered by starvation. The three migration peaks seemed to be oriented by seasonal volatile organic compounds (VOCs) emitted by plant tissues, including 2,6,10-trimethyltridecane, a main compound of faba bean and pea flowers; 1-octen-3-ol, a dominant compound of soybean leaves and flowers; and EED, a universal VOC of yellowish tree leaves in autumn, which was supported by that the attractiveness of those compounds to R. pedestris was adaptive across seasons in the field.
Keywords: VOCs; agricultural ecosystem; insect pest control; seasons

Conifer phenolic metabolism during the spruce–beetle–fungus interaction

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Abstract: The successful invasion and colonization of Norway spruce (*Picea abies*) by the Eurasian spruce bark beetle (*Ips typographus*) and its symbiotic fungi cause extensive damage to conifer forests. Norway spruce defends itself through an integrated array of chemical and physical barriers, among which phenolic compounds play a central role as defensive secondary metabolites. These phenolics, including antimicrobial stilbene and flavonoid glucosides, accumulate in the phloem and are ingested by attacking beetles. While the role of these compounds in plant defense is well established, their contribution to bark beetle resistance against fungal pathogens remains unclear. We demonstrate that *I. typographus* hydrolyzes phenolic glucosides into their corresponding aglucones, which exhibit enhanced antifungal activity. Conversely, the entomopathogenic fungus *Beauveria bassiana*, a natural enemy of *I. typographus*, detoxifies these aglucones by converting them into methylglucoside derivatives. In this study, we investigated the metabolic fate of spruce phenolic compounds within bark beetles, then assessed their role in determining beetle susceptibility to *B. bassiana*. We isolated *B. bassiana* strains from beetles killed by fungal infection and demonstrated their ability to detoxify both spruce- and beetle-derived phenolics. Candidate detoxification genes were identified, and corresponding enzymes were heterologously expressed and biochemically characterized. Using gene knockout mutants, we confirmed the functional role of these enzymes in phenolic detoxification and showed that this metabolic process contributes to fungal virulence in *I. typographus*.

An egg parasitoid assesses host egg quality from afar using oviposition-induced plant volatiles

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Abstract: Parasitoids of herbivores exploit inducible plant volatiles to find plants with potential hosts from a distance, whereas at close range they typically use host-derived cues to pinpoint and identify suitable hosts. Here we show, however, that the egg parasitoid *Trichogramma japonicum* assesses host egg quality far more efficiently by remotely using oviposition-induced plant volatiles (OIPVs). In olfactometer assays, female *T. japonicum* wasps showed a strong preference for the odor of rice plants carrying 2-d-old eggs of the rice leaf folder *Cnaphalocrocis medinalis*, over the odor of plants with younger or older eggs, a preference that correlated with higher parasitism rates. In accordance with the preference-performance hypothesis, the offspring of *T. japonicum* showed superior performance in 2-d-old eggs, including shorter development times and higher eclosion rates. Volatile analysis revealed significantly increased emission of D-limonene and α-pinene from plants with 2-day-old eggs, and we found that synthetic versions of these two monoterpenes were highly attractive to the wasp. Knockout rice plants deficient in D-limonene and α-pinene synthesis lost their appeal to the wasps, but attraction could be restored by dispensing synthetic versions of the attractants alongside the knockouts. These findings reveal a novel and highly efficient host-assessment strategy in egg parasitoids, whereby plant-provided cues inform the wasps about host quality from afar. This discovery is illustrative of the clever strategies that have evolved out of plant-insect interactions and offers fresh ideas to optimally exploit plant traits for biocontrol approaches against *C. medinalis*, a major rice pest.

Keywords: *Cnaphalocrocis medinalis*, *Trichogramma japonicum*, oviposition-induced plant volatiles (OIPVs), egg parasitoids, host selection

Cross-Kingdom RNAs in Insect-Plant Interactions

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Abstract: Cross-kingdom RNAs are RNA molecules that traffic between organisms from different kingdoms, where they play functional roles in their hosts. These RNAs have been widely observed in various parasite-host interactions, particularly in cross-kingdom RNA interference (RNAi) involving small RNAs. Extensive studies have explored small RNA-mediated interactions in microorganism-plant and insect-plant systems. However, the role of long RNAs in cross-kingdom communication remains largely unexplored.

Since the discovery of Ya1 in *Myzus persicae*—an aphid lncRNA that migrates into host plants and acts as a virulence factor to promote aphid colonization— we have found that many aphid species can secrete lncRNAs into the host plants. Additionally, we found that the brown planthopper (*Nilaparvata lugens*) also translocates the lncRNAs into rice plants. In this talk, I will describe the discovery of *Ya1* and discuss the functional roles of insect-derived cross-kingdom lncRNAs in host plants. I will then introduce RNA switch-controlled RNA-triggered fluorescence (RNA switch-RTF), an innovative technology for visualizing insect RNAs in living plants. Finally, I will demonstrate how RNA switch-RTF can be leveraged to enhance plant defense by detecting insect-derived RNAs.

A plant virus manipulates both its host plant and the insect that facilitates its transmission

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Abstract: Tomato yellow leaf curl virus (TYLCV), a devastating pathogen of tomato crops, is vectored by the whitefly *Bemisia tabaci*, yet the mechanisms underlying TYLVC epidemics are poorly understood. We found that TYLCV triggers the upregulation of two β-myrcene biosynthesis genes in tomato, leading to the attraction of non-viruliferous *B. tabaci*. We also identified BtMEDOR6 as a key whitefly olfactory receptor of β-myrcene involved in the distinct preference of *B. tabaci* MED for TYLCV-infected plants. TYLCV inhibits the expression of BtMEDOR6, canceling this preference and thereby facilitating TYLCV transmission to uninfected plants. Greenhouse experiments corroborated the role of β-myrcene in whitefly attraction. These findings reveal a sophisticated viral strategy whereby TYLCV modulates both host plant attractiveness and vector olfactory perception to enhance its spread.

Plant volatiles mediated the orientation preference of slugs to different plant species

Te Zhao

Abstract: Slugs mechanically damage plant leaves, resulting in significant economic losses. However, there are limited cost-efficient strategies available in slug management. Studying how slugs use plant volatile organic compounds (VOCs) to locate host plants can provide valuable insights for the development of effective attractants and repellents. We analyzed the volatomics of Ginkgo biloba seed exocarps, lettuce, cabbage, young and old tobacco seedlings. We screened the dominating VOCs and found that γ-octalactone and tetradecane were highly attractive to slugs, even at low concentrations. Butyl caprate attracted slugs at medium to low concentrations, and pentadecane was attractive at medium to high concentrations. Ethyl salicylate, 2-(2-butoxyethoxy)-ethanol acetate, 1,4-dihydro-4-oxopyridazine and trans-2-undecenal were attractive only at high concentrations. Different VOC mixtures were highly attractive under both laboratory and field conditions. These findings indicate that plant volatile-based baits are effective for trapping large numbers of slugs, offering valuable insights for the development of botanical attractants.

Phthorimaea absoluta uses *Bemisia tabaci* damage-induced eugenol to avoid competition and parasitism

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Abstract: Insects in natural ecosystems frequently navigate complex multi-species interactions with competitors and predators, yet the mechanisms by which they exploit chemical signals to optimize their fitness remain understudied. Here we find that *Phthorimaea absoluta*, a major tomato pest, strategically uses eugenol, a volatile compound induced by *Bemisia tabaci* damage, to evade competition with *Phthorimaea operculella* and parasitism by *Trichogramma chilonis*.

First, we observed that *P. absoluta* prefers *Bemisia tabaci*-damaged tomato plants, while *P. operculella* avoids them. Using gas chromatography-mass spectrometry (GC-MS), we confirmed that *B. tabaci* damage induces eugenol release. Subsequent Y-tube olfactometer and oviposition assays demonstrated that *P. absoluta* is strongly attracted to eugenol, whereas *P. operculella* exhibits avoidance. Through ectopic expression in *Drosophila* melanogaster OR67d neurons, we identified two female-biased odorant receptors—PabsOR36 in *P. absoluta* and PopeOR46 in *P. operculella*—that specifically detect eugenol, indicating a conserved peripheral olfactory detection mechanism mediating opposing behavioral responses in these two *Phthorimaea* species. Finally, we found that eugenol repels *Trichogramma chilonis*, an effective parasitoid of *P. absoluta*, and its application significantly reduces parasitism of *P. absoluta* eggs on tomato plants.

These findings highlight the pivotal role of a single odorant in orchestrating multi-species interactions, providing insights for developing targeted pest management strategies.

Keywords: Trophic interactions, Odorants, Odorant receptors, *Parasitoids*, Pest management

Development of a Novel Attractant-Baited Sticky Board and Its Application for the Highly Efficient Control of Aleurocanthus spiniferus in Tea Plantations

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Abstract: *Aleurocanthus spiniferus* is an important tea plant pest globally. The effective chemical control of the whitefly is challenging due to its overlapping generations of a large individual number of minuscule wax-covered nymphs and pupae inhabiting the underside of mature leaves within shaded tea bushes. Moreover, the pandemic of tea sooty mold always occurs with its outbreaks. After emergence, whitefly adults engage in mating, ovipositing, excreting honeydew, piercing, and sucking on tea shoots. Our study showed that whitefly adults highly preferred the jasmine yellow sticky boards, each baited with a tea plant volatiles-based 6-component attractant lure (60 mg loading) consisting of benzaldehyde, 1-hexanol, methyl salicylate, *trans*-2-hexenal, *cis*-3-hexen-1-ol, and linalool at a 1:2:4:4:7:12 ratio, denoted as the *Aleurocanthus spiniferus* attractant with a sticky jasmine yellow board (ASASJYB). The effective trapping distance of ASASJYBs was determined to be 12 m, with whitefly adult catches on each board ranging from dozens to 40,000 individuals within several days. Trapping by ASASJYBs could accurately predict the beginning, peak, and ending periods of the emergence and also catch significant numbers of the gravid females. From end March to early April, application of ASASJYBs at a rate of 225 traps per ha in tea plantations could catch the most overwintering-generation adults and consequently suppress the whole year’s whitefly nymph and pupal populations below the control threshold. In main Chinese tea-growing regions, ASASJYBs have been widely used to control the whiteflies efficiently and in an eco-friendly manner.

Keywords: Tea plantation;Aleurocanthus spiniferus;Attractant;Sticky jasmine yellow board;Forecast and prediction;Mass-trapping

Cellular and Molecular Basis of DEET Reception in Aedes Mosquito

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Abstract: The female Aedes aegypti mosquito seeks hosts for blood feeding to facilitate the development of its eggs, concurrently acting as a vector for transmitting numerous pathogenic viruses, including dengue, Zika, and yellow fever viruses. Currently, one of the most crucial repellents for controlling Ae. aegypti is DEET (N,N-Diethyl-meta-toluamide), which achieves spatial repellency by activating the mosquito's olfactory nervous system. However, the mechanism by which Ae. aegypti detects DEET has remained unclear. Therefore, this study employed an integrated approach combining neuroelectrophysiology, gene editing, and behavioral assays to elucidate the cellular and molecular mechanisms underlying DEET perception in Ae. aegypti. We conducted a large-scale screen of olfactory sensilla on Ae. aegypti antennae and identified sst-type sensilla exhibiting specific excitatory responses to DEET. Through SMART-seq transcriptome sequencing, we discovered multiple putative odorant receptors potentially responsible for DEET detection. Using the Xenopus oocyte expression system and two-electrode voltage clamp recording, we determined that one of these receptors, OR27, elicited strong currents in response to DEET, which was further validated using the Drosophila "empty neuron" system. Moreover, we localized the expression of OR27 to specific neuronal cells in the antennae using the Q-system labeling technique. Fluorescence-guided single sensillum recordings confirmed that the OR27-expressing olfactory sensilla exhibited robust neural responses to DEET. Additionally, we knocked out the OR27 gene of Ae. aegypti using CRISPR-Cas9 gene editing technology. Electroantennogram (EAG) assays revealed a significant reduction in the antennal response to DEET in the OR27 homozygous mutant mosquitoes. Crucially, behavioral assays demonstrated a significantly diminished repellent efficacy of DEET against these mutants. These results conclusively demonstrate that OR27 serves as a key receptor for DEET detection in Ae. aegypti, playing an essential role in mediating the repellent effect of DEET.
Keywords: mosquito; olfaction; odorant receptor; repellency

Male derived PBP4 is essential for sperm competition by mediating sperm motility in moths

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Abstract: Male moths rely on antennal olfactory sensilla to detect female-emitted sex pheromones during mate localization, a process critically mediated by pheromone-binding proteins (PBPs) that facilitate ligand transport to dendritic membrane-bound pheromone receptors. Intriguingly, a divergent PBP paralog (PBP4) in noctuid moths has been identified exhibiting predominant expression in the male reproductive system, though its functional significance remained elusive. In this study with *Spodoptera exigua*, we demonstrated that PBP4 is specifically expressed in male accessory glands (MAGs) and transferred to females during copulation. CRISPR-mediated PBP4 knockout (PBP4-/-) significantly reduced male reproductive success via impaired sperm competition, evidenced by diminished offspring sired. Transcriptomic and qPCR analyses revealed expressional correlation between PBP4 and the odorant receptor coreceptor (Orco), and similar sperm competition deficits were observed in Orco-/- males. Furthermore, both mutants exhibited compromised sperm motility and reduced sperm transfer from spermatophores to spermathecae. In vitro sperm motility assays showed that a specific agonist of Orco, VUAA1, robustly enhanced sperm motility in an Orco-dependent process. Analyses of four additional moth species, including noctuids and non-noctuids, revealed a similar specific expression in the male reproductive tracts in all of them. Our findings unveil a non-canonical role for PBP4 in reproductive fitness and evolutionary conservation of the PBP-ORx/Orco signaling pathway, and in regulating sperm competitiveness.

Molecular profiling of chemical signals enhancing plant invasion by shaping antagonistic and mutualistic associations

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Abstract: Non-native plants often experience reduced antagonistic pressures and potentially increased mutualistic associations in their introduced ranges. However, the mechanisms linking aboveground and belowground interactions remain poorly understood. Using the invasive tree *Triadica sebifera* as a model system, we tested the hypothesis that genetic differentiation drives evolutionary shifts in root exudate chemistry, thereby enhancing arbuscular mycorrhizal (AM) fungal symbiosis.

Compared to plants from native populations, those from introduced populations exhibited significantly higher root exudate concentrations of key signaling compounds, notably flavonoids (quercetin, quercitrin) and strigolactones (5-deoxystrigol). These elevated concentrations were positively correlated with increased AM fungal colonization and greater biomass production. Experimental application of exudates from introduced populations, as well as the specific compounds quercetin and the strigolactone analog GR24, strongly stimulated AM fungal spore germination and colonization. Conversely, adsorptive removal of root exudates using activated carbon significantly reduced AM fungal colonization. Genetic analyses revealed that these chemical differences were associated with the upregulation of key biosynthetic genes—specifically, the flavonoid biosynthesis gene FLS and the strigolactone biosynthesis gene DAD1—in introduced populations.

Furthermore, invasive populations demonstrated enhanced tolerance to aboveground herbivory by both specialist and generalist insects. They frequently exhibited higher relative growth rates and more pronounced increases in AM fungal colonization, particularly under specialist herbivory. Herbivory induced population- and insect-dependent shifts in flavonoid levels across leaf, root, and root exudate tissues. What's more, Jasmonate signaling, mediated by compounds such as methyl jasmonate, played a crucial role in aboveground-belowground communication, specifically linking leaf herbivory to root flavonoid accumulation.

In summary, introduced *T. sebifera* populations have evolved enhanced AM mutualism through the genetic upregulation of root-exuded signaling compounds, flavonoids and strigolactones. This supports the Evolution of Increased Competitive Ability (EICA) hypothesis: release from natural enemies in the introduced range enables resource reallocation from defense towards metabolites that enhance beneficial mutualisms. Herbivory modulates these interactions via hormonal signaling and tissue-specific metabolic changes, ultimately influencing symbiosis and plant growth. This study provides a mechanistic framework linking evolved defense strategies, root exudate chemistry, and mutualisms, advancing our understanding of plant invasion success.

Neuroanatomical Study of Antennal Lobe by 3D Morphological and Quantitative Analysis in Yellow Peach Moth (Dichocrosis punctiferalis)

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Abstract: The yellow peach moth Dichocrocis punctiferalis, a highly polyphagous insect, is a serious agricultural pest that inflicts damage not only on horticultural crops but also on fodder and cash crops. Its ecological success is largely attributed to its advanced sensory and pheromonal systems. Understanding the sensory mechanisms of this pest is essential for developing targeted control strategies. In this study, we investigated the primary olfactory center and antennal lobe development in D. punctiferalis. Insect brain dissected and fixed in paraformaldehyde (PFA) followed by immunohistochemistry and the application of the neuronal tracer tetramethylrhodamine dextran performed. Confocal microscopy revealed the presence of 66 to 70 glomeruli in the antennal lobes of both sexes, including sex-specific glomeruli (MS1, MS2 in males; FS1, FS2 in females). The volume of ordinary glomeruli ranged from 1000 μm^3 to 2000 μm^3. The male-specific glomeruli, identified as part of the macroglomerular complex (MGC), exhibited significantly ($p < 0.001$) larger volumes compared to female and other male glomeruli. Olfactory sensory neurons (OSNs), responsible for detecting pheromonal cues from the environment, were visualized using mass staining techniques, revealing their projections and interactions with glomeruli, and the subsequent signal transmission to higher brain centers. Additionally, labial palp sensory neurons were identified innervating the G38 glomerulus, located in the posteroventral region of the antennal lobe. This study enhances our understanding of the olfactory architecture of D. punctiferalis and provides a foundation for future research in insect chemical ecology and the development of pheromone-based pest management strategies. Funding: The National Natural Science Foundation of China (32370525; 32130089).

Keywords: antennal lobe;glomerulus;olfactory sensory neuron;three-dimensional reconstruction

Defense trade-off in wheat: Fall armyworm-induced resistance impairs adaptation in the grain aphid Sitobion avenae

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Abstract: The fall armyworm, *Spodoptera frugiperda*, is one of the most destructive phytophagous pests worldwide. As an invasive species in China, it causes severe damage to wheat; however, the molecular-level defense responses of wheat to *S. frugiperda* infestation remain unclear. In this study, dynamic transcriptome analysis manifested that *S. frugiperda* feeding significantly altered the expression of wheat genes associated with abiotic/biotic stress resistance and secondary metabolism. Targeted metabolomics revealed that defense-related compounds—the phytohormone jasmonic acid and benzoxazinoids (e.g., indole and DIMBOA)—were also significantly increased after *S. frugiperda* feeding. Herbivore-induced plant volatiles (HIPVs) emitted by infested wheat attracted the parasitic wasp *Telenomus remus*, demonstrating an indirect defense mechanism. In addition, wheat plants pre-infestation with *S. frugiperda* significantly inhibited the performance of subsequent moths. Notably, *S. frugiperda* infestation reduced wheat's susceptibility to the native phloem-feeding pest, the grain aphid *Sitobion avenae*. Our findings elucidate wheat's dynamic direct/indirect defenses against *S. frugiperda*, offering potential pest-control strategies and insights into plant-mediated interactions among phytophagous insects.