Lucas Denadai de Campos

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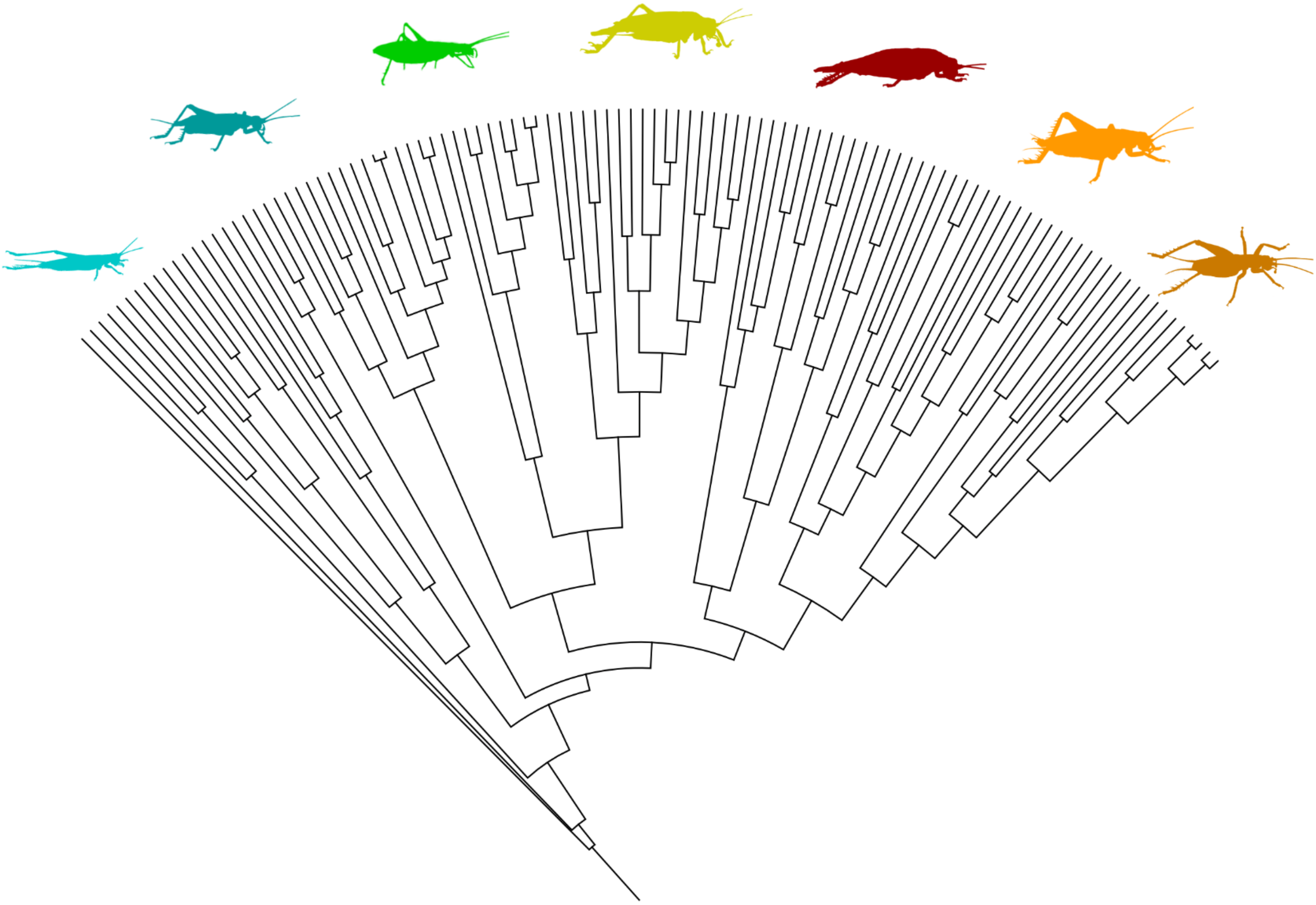
Phylogeny, divergence times, and evolution of Oecanthidae n. status (Insecta, Orthoptera, Grylloidea)



São Paulo

2022

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Tese apresentada ao Instituto de Biociências da Universidade de São Paulo, para a obtenção de Título de Doutor em Ciências Biológicas, na Área de Zoologia.

Orientador: Prof. Dr. Silvio Shigueo Nihei

Coorientadora: Profa. Dra. Laure Desutter-Grandcolas

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Aos meus pais e minha
amada companheira Letícia

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Índice

Resumo

A ordem Orthoptera, conhecida principalmente pelos grilos e gafanhotos, é distribuída mundialmente com quase 30 mil espécies válidas, sendo considerada a ordem mais diversa dentre os Polyneoptera. Em Orthoptera, os grilos verdadeiros (Grylloidea) são organismos frequentemente utilizados como organismos modelo para diversos tipos de estudo como comunicação acústica, comportamento, ecologia e até neurobiologia. No entanto, poucos desses estudos são focados no contexto evolutivo, uma vez que ainda existem poucas hipóteses filogenéticas para o grupo. Além disso, a comunicação acústica desses insetos é considerada um dos elementos mais intrigantes e presentes em sua evolução. Porém, apesar de ser um tema constantemente retratado pela comunidade científica, poucos trabalhos o abordam em um contexto filogenético. No primeiro capítulo dessa tese, apresentamos uma hipótese filogenética para uma nova família de grilos, grupo-irmão de Gryllidae n. def.: Oecanthidae n. status. As análises filogenéticas possuem como fonte de caracteres dados moleculares e morfológicos, para parcimônia e máxima verossimilhança, e dados moleculares para a análise de tempos de divergência (inferência bayesiana). Foram utilizados 107 terminais de todas as regiões biogeográficas e seis fósseis para a calibração da árvore filogenética. Todas as análises resultam em Oecanthidae n. status composta por quatro subfamílias, Euscyrtinae, Oecanthinae n. def., n. status, Podoscirtinae n. def. e Tafaliscinae n. def. n. status. Baseado nos resultados obtidos, nós revisamos a definição e a classificação interna das subfamílias, supertribos (propostas neste trabalho) e tribos. Phyllogryllini n. tribo é definida. Também atualizamos as diagnoses, listamos os gêneros de cada uma das tribos e as apomorfias dos táxons supragenéricos. Também é apresentada uma chave de identificação para todos os níveis taxonômicos de Oecanthidae n. status mais todos os gêneros de Tafaliscinae n. def. n. status. No segundo capítulo, utilizamos a filogenia de Oecanthidae, baseada em dados moleculares e morfológicos, para realizar uma reconstrução de estados ancestrais relacionados a comunicação acústica. Os caracteres são estruturas das asas anteriores, as próprias asas anteriores e tímpanos. Foram analisados seis caracteres no total. Nossos resultados demostram perdas de caracteres relacionados a comunicação acústica para vários táxons independentemente ao longo do tempo. Ao final, discutimos as possíveis causas da perda da capacidade de produção do som em Oecanthidae além das suas alternativas para uma comunicação eficiente não dependente de sinais acústicos.

Abstract

Orthoptera, mainly known by crickets and grasshoppers, is distributed worldwide with almost 30,000 valid species. The order is considered the most diverse order within Polyneoptera. In Orthoptera, true crickets (Grylloidea) are frequently used as models for many areas of science as acoustic communication, behavior, ecology, and neurobiology. However, only a few studies are focused on a phylogenetic context since the number of phylogenetic hypotheses for this group is low. Besides, the acoustic communication of these insects is considered an essential element of their evolution. Although it is a subject constantly debated, only a few works are in a phylogenetic frame. In the first chapter of this thesis, we present a phylogenetic hypothesis for a new family of crickets, sister-group of Gryllidae n. def.: Oecanthidae n. status. The phylogenetic analyses are based on molecular and morphological data for maximum likelihood and parsimony criteria and molecular data for divergence times analysis (Bayesian inference). Were used 107 terminals from all biogeographic regions and six fossils to calibrate the phylogenetic tree. All analyses result in Oecanthidae n. status composed of four subfamilies: Euscyrtinae, Oecanthinae n. def., Podoscirtinae n. def., and Tafaliscinae n. def. n. status. We revise the definition and internal classification of subfamilies, supertribes (proposed herein), and tribes based on our results. Phyllogryllini n. tribe is defined. We also update the diagnosis of suprageneric groups, list their apomorphies, and list the genera of each tribe. An identification key is proposed for all taxonomic levels of Oecanthidae n. status plus all Tafaliscinae n. def., n. status genera. In Chapter 2, we use the phylogeny of Oecanthidae, based on molecular and morphological characters, to reconstruct the history of characters related to acoustic communication in crickets as forewings structures, the forewings itself, and tympana. In total, the history of six characters are analyzed. Our results demonstrate the loss of characters related to acoustic communication along the time independently for many taxa in this family of crickets. Several of these taxa are not able to use forewings to stridulate. We discuss the potential causes of losing the capacity of sound-producing and hearing and their alternatives for efficient communication not exclusively based on sounds.

Introdução Geral

Os Orthoptera são insetos frequentemente utilizados como modelos de estudo em várias áreas do conhecimento biológico como comunicação acústica (Bailey *et al.*, 1991, Gerhardt & Huber, 2002), neurobiologia (Hedwig, 2014, Pollack, 2010), comportamento (Benavides-Lopez *et al.,* 2020, Huber *et al.,* 1989, Lobregat *et al.,* 2019), biogeografia (Campos *et al.,* 2021, Dong *et al.,* 2018, Vicente *et al.,* 2017), e evolução (Desutter-Grandcolas, 2003; Jost & Shaw 2006, Song *et al.,* 2015, 2020).

No entanto, não é possível avançar nessa ou outras áreas da Biologia no que se diz respeito a hipóteses evolutivas sem hipóteses filogenéticas e uma classificação robusta. Árvores filogenéticas são ferramentas essenciais para estudos evolutivos, padrões biogeográficos além de uma categorização bem embasada. Por décadas autores tem se dedicado na organização de Orthoptera e suas linhagens internas utilizando filogenias como base para sua classificação (Chintauan-Marquier *et al.,* 2016, Desutter, 1987, Desutter-Grandcolas, 2003, Flook & Rowell, 1997, Gwynne 1995, Legendre *et al.,* 2010, Mariño-Pérez & Song, 2018, Robillard & Desutter-Grandcolas, 2004, Robillard & Desutter-Grandcolas, 2011, Song *et al.,* 2015, 2020). No entanto, vários grupos dessa ordem continuam pouco estudados e conhecidos devido à ausência de especialistas (Godfray, 2002), a dificuldade de coleta (Campos & Desutter-Grandcolas, 2020) e áreas pouco ou não amostradas para esse táxon.

Hipóteses filogenéticas também são necessárias para se estimar os tempos de divergência das linhagens. Árvores calibradas temporalmente são ferramentas cruciais para se entender padrões biogeográficos e processos evolutivos. Atualmente. É relativamente simples obter uma árvore datada: reduzindo custos para se obter dados moleculares e desenvolvendo novas ferramentas e metodologias (Bleidorn, 2017). Além disso, o registro fóssil aumenta a cada dia, expandindo as oportunidades que não eram possíveis anos atrás.

Orthoptera compreende quase 29 mil espécies válidas distribuídas mundialmente exceto os polos (Cigliano *et al.,* 2022). A origem da ordem é estimada em aproximadamente 355 milhões de anos atrás (Maa), no Carbonífero Tardio, e é dividida em duas subordens monofiléticas, Caelifera (~320 Maa) e Ensifera (~308Maa) (Song *et al.,* 2015, 2020). A subordem Caelifera é representada pelos gafanhotos, locustas, manés-magros, gafanhotos-palhaço, entre vários outros. Já Ensifera é representada pelos grilos verdadeiros, grilos de Jerusalém, paquinhas e esperanças.

Dentro de Ensifera, a única e mais recente classificação de Grylloidea, popularmente conhecida pelos grilos verdadeiros, é definida por quatro famílias: Mogoplistidae Costa, 1855; Trigonidiidae Saussure, 1874; Phalangopsidae Blanchard, 1845; e Gryllidae Laicharting, 1781 (Chintauan-Marquier *et al.,* 2016; Cigliano *et al.,* 2022). Essa classificação é baseada em uma árvore filogenética construída utilizando seis marcadores moleculares (mitocondriais e nucleares) e 205 terminais de todas as regiões do planeta, exceto os polos. Nesta classificação, a família Gryllidae é dividida em Clados F e G. O Clado G representa Gryllidae *stricto sensu*. Ao mesmo tempo, o Clado F, composto principalmente por táxons pertencentes ao "Grupo de Subfamílias Podoscirtinae (GSP) (Cigliano *et al.,* 2022; Gorochov, 2015), incluindo Oecanthinae Blachard, 1845 e excluindo Pentacentrinae Saussure, 1878, o qual pertence ao Clado G na filogenia de Chinatuan-Marquier *et al.* (2016) (Fig. 1). Nesse trabalho os autores mencionam a necessidade de que essa situação seja reanalisada, aumentado as amostragens de ambos os clados.

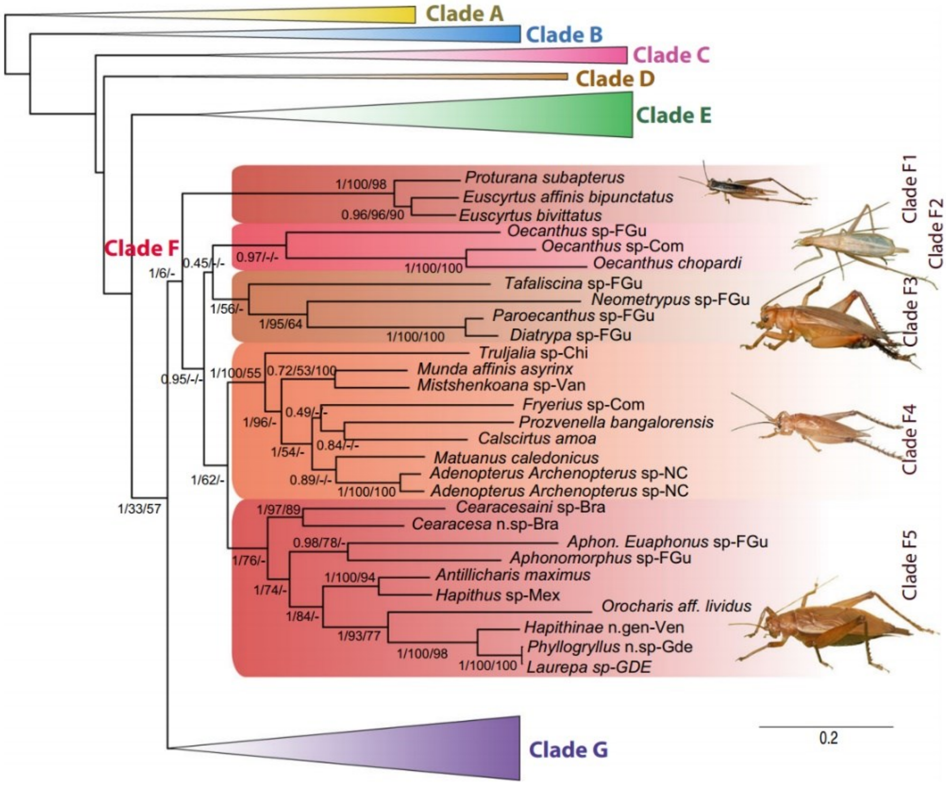


Figura 1. Filogenia de Chitauan-Marquier *et al.* (2016) evidenciando as linhagens do clado F.

GSP, proposto por Gorochov (2015), é um agrupamento temporário adotado pelo catálogo online Orthoptera Species File (OSF) (Cigliano *et al.,* 2022). Além disso, esse grupo não possui evidencias que o suportem, como uma árvore filogenética ou mesmo um conjunto de caracteres diagnósticos. Tanto o Clado F (Chintauan-Marquier *et al.,* 2016) como o GSP indicam a necessidade de novos estudos filogenéticos focados nessa linhagem de grilos. Assim, propondo uma classificação robusta além de servir como base para futuros estudos evolutivos para esse clado. De acordo com Cigliano *et al.* (2022), GSP atualmente inclui quatro subfamílias: Euscyrtinae Gorochov, 1985; Hapithinae Gorochov, 1986; Pentacentrinae Saussure, 1878; e Podoscirtinae Saussure 1878.

Oecanthidae n. status: breve histórico do nome

Nesta tese, é apresentada o estudo filogenético do Clado F de Chintauan-Marquier *et al.* (2016) e GSP (Cigliano *et al.,* 2022). Esse estudo apresenta árvores filogenéticas globalmente bem suportadas, além de caracteres diagnósticos, para definir a quinta família de Grylloidea, grupo irmão de Gryllidae n. def.: Oecanthidae n. status. O nome da família foi escolhido por ser o nome mais antigo dentre os nomes pertencentes a este clado de grilos arborícolas.

O nome Oecanthites foi erigido por Blanchard (1845) no século XIX como um grupo dentro da tribo Grylliens, incluindo o gênero *Oecanthus* Serville, 1831. Esse grupo era caracterizado por possuir três tarsômeros nas pernas anteriores e médias, e as pernas posteriores com quatro. Anos depois, Saussure (1874) usou o nome Oecanthiens como uma tribo da família Gryllidae. A tribo era distinguida principalmente pelo formato dos tarsômeros. Mais tarde, o mesmo autor utilizou o nome Oecanthinae como tribo (Saussure 1897). Ele se referia a esses grilos como insetos delgados e delicados, de coloração verde esbranquiçados, asas desenvolvidas em ambos os sexos e o ápice do ovipositor com pequenos dentes.

No mesmo ano, Scudder (1897) usou Oecanthinae como subfamília de Gryllidae. Chopard (1968) pela primeira vez nomeou essa linhagem como uma família, Oecanthidae. O autor considerou esse grupo uma família diferente de Gryllidae devido a várias diferenças entre elas (Chopard 1951, 1968).

Alexander e Otte (1983) utilizaram um sistema de subfamílias de Gryllidae. Eles consideraram que Oecanthinae "não é mais distinto que Myrmecophilinae ou Mogoplistinae", dois grupos com modificações morfológicas notáveis, rebaixando essa linhagem novamente a subfamília. A definição desses grilos agora incluía insetos prógnatos, com garras tarsais bilobadas ou bífidas, espelhos nas asas dos machos bem desenvolvido e divido por duas veias.

Oecanthidae foi retomado uma segunda vez por Desutter (1987). Dessa vez, o nome foi incluído em uma hipótese filogenética onde "Neoaclidae" (atualmente Neoaclina: Phalangopsidae) era o grupo-irmão de Oecanthidae baseado em estruturas genitais dos machos. Otte, na primeira edição do Orthoptera Species File (1994), voltou a usar o sistema subfamilial de Gryllidae, novamente considerando o táxon como subfamília e não família como anteriormente. Essa nomenclatura tem sido adotada atualmente com algumas pequenas modificações internas, principalmente tribos e gêneros (Cigliano *et al.,* 2022).

Apenas uma vez Oecanthinae foi relacionada com outras famílias presentes no Clado F de Chintauan-Marquier *et al.,* (2016). No entanto, esse relacionamento é representado por um dendrograma e não apresenta nenhuma metodologia ou evidências para sustentá-lo, sendo demonstrado de maneira intuitiva (Gorochov 2015) (Fig. 2).

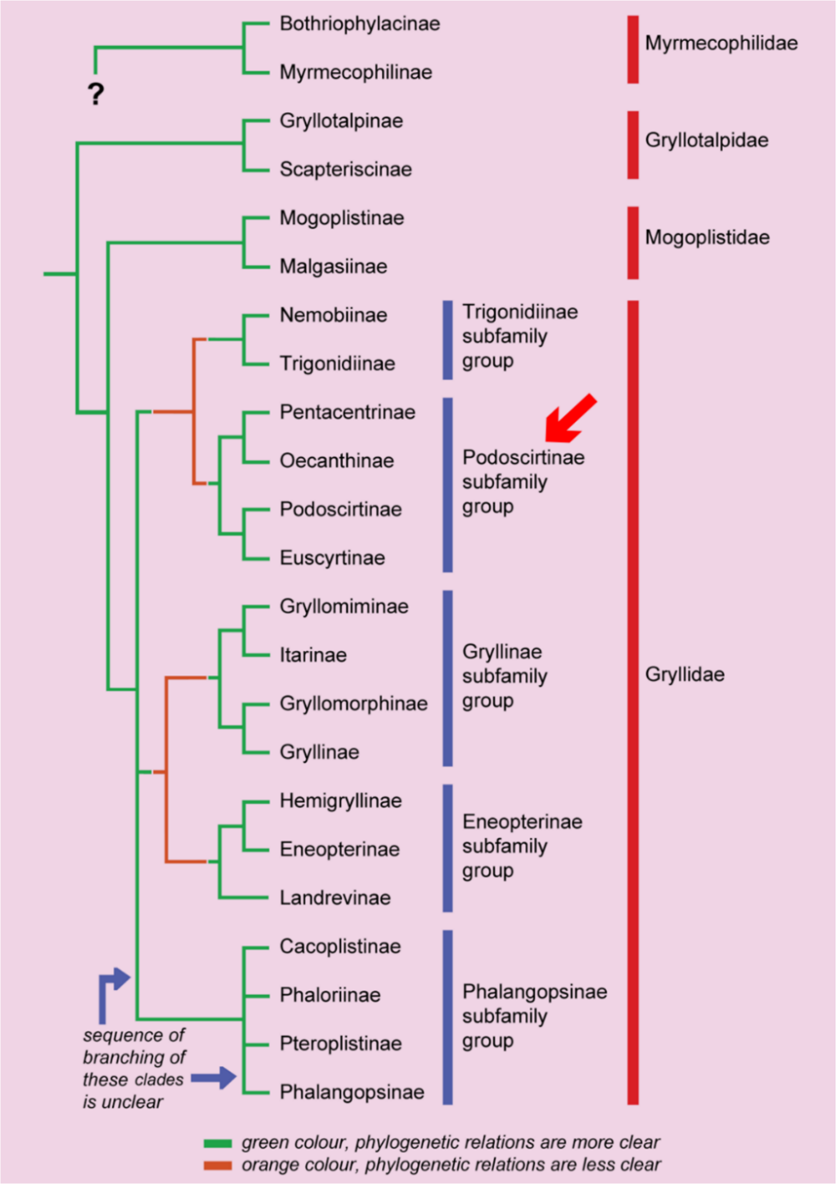


Figura 2. Dendrograma de Gryllidea proposto intuitivamente por Gorochov (2015).

Oecanthidae n. status, a quinta família de Grylloidea

Oecanthindae n. status é uma família distribuída mundialmente com uma grande diversidade de formas e habitats. Esses grilos são encontrados em diversos extratos vegetais (com raras exceções) que vão desde gramíneas até os elevados dosséis da Floresta Amazônica (Campos *et al.,* 2020, Campos & Desutter-Grandcolas, 2020, Otte 1994b, Otte & Alexander, 1983, Otte & Pérez-Gelabert, 2009). No que se diz respeito a morfologia, eles também possuem uma grande variedade de tamanho (~10mm – ~40mm), morfologia das asas com estruturas acústicas (de complemente funcionais até ausentes, com todos os estágios intermediários), desenvolvimento das asas (desde espécies ápteras até com longas asas cobrindo totalmente o abdome) e uma vasta diversidade de formatos do ovipositor, principalmente no seu ápice (Anso *et al.,* 2016, Campos & Desutter-Grandcolas, 2020, Desutter-Grandcolas *et al.,* 2016, Gorochov, 2017, Otte & Alexander, 1983, Otte & Pérez-Gelabert, 2009) (Fig. 3).

Suas linhagens monofiléticas, como subfamílias e supertribos, possuem um padrão congruente com as principais regiões biogeográficas, além de apresentarem padrões de especialização de habitat. Tafaliscinae n. def. n. status e Diatrypidi n. status (Oecanthinae n. def.) são exclusivos da Região Neotropical, Hapithidi n. status (Podoscirtinae n. def.) está no Neotrópico e ao sul da Região Neártica. Por outro lado, Podoscirtidi n. status (Podoscirtinae) ocorre na Região Paleotropical e Oceania. Euscyrtinae está no Paleotrópico, mas também possui representantes na América Central (Região Neotropical). Oecanthidi n. status (Oecanthinae n. def.) é mundialmente distribuída (Cigliano *et al.,* 2022). Além disso, a diversidade morfológica desses grilos fornece pistas cruciais para compreender a sua afinidade com as plantas e como eles as usam como habitat e recurso para seu sucesso evolutivo.

Essa notável diversidade morfológica e geográfica torna esse grupo um excelente candidato para estudo como comportamento, bioacústica, biogeografia, diversificação e evolução de caracteres. Sem mencionar na influência dos eventos geológicos e ambientais passados na diversificação desse clado (Grant *et al.,* 2017).

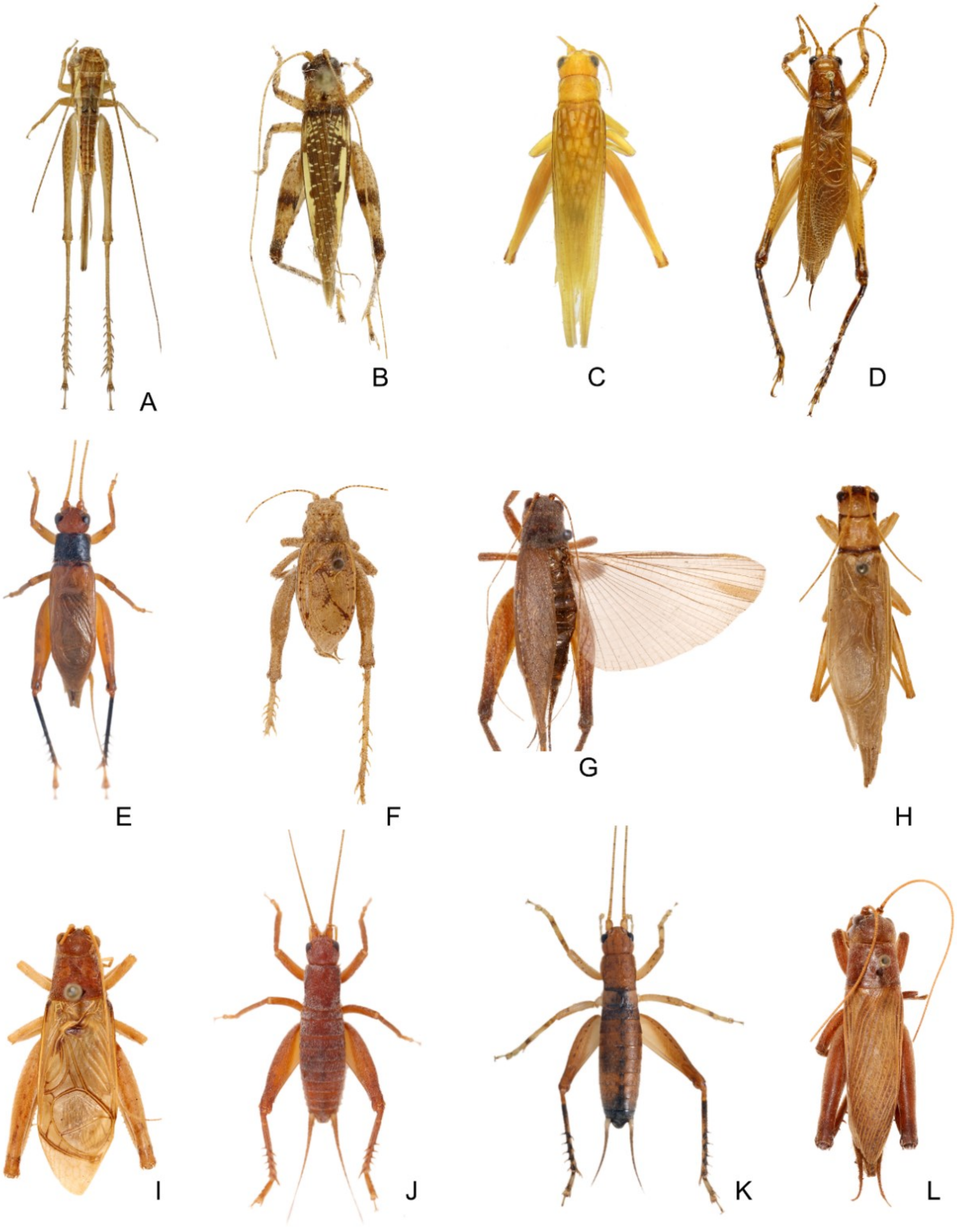


Figura 3. Diversidade de Oecanthidae n. status: A-*Proturana subapterus*, fêmea; B-*Munda asyrinx*, macho; C-*Adenopterus caledonicus*, macho; D-*Fryerius* sp., macho; E-*Diatrypa (Diatrypa) tuberculata*, macho; F-*Hapithus (Hapithus) vagus*, macho; G-*Aphonomorphus* (*Aphonomorphus*) *tenebrosus*, macho; H-*Ectotrypa repentina*, macho; I-*Paroecanthus mexicanus*, macho; J-*Neometrypus couriae*, macho; K-*Neometrypus catiae*, macho; L-*Tafalisca furfurosa*, macho.

Os grilos estão entre os primeiros músicos do planeta e estão presentes no cenário noturno há pelo menos 200 milhões de anos (Nel, 2021). Os sons produzidos principalmente pelos machos desses insetos são relacionados, na maioria das vezes, com o comportamento reprodutivo como cantos de chamado, corte, cópula e até pós-cópula (os dois últimos menos frequentes) (Alexander, 1962, Huber *et al.,* 1989). Porém, a sinalização acústica dos grilos também é utilizada em outras situações além de interações macho-fêmea. Sabe-se também que o repertório sonoro pode variar além dos machos chamarem fêmeas, apresentando outras funções relacionadas a cuidado parental, territorialidade e agressividade (Huber *et al.,* 1989). O som produzido por cada espécie de grilo é diferente de outras espécies no mesmo local e tempo, e, apesar dos grilos se comunicarem intraespecíficamente, também se comunicam interespecificamente a fim de evitar parasitoides e predadores (Alexander, 1962, Burk, 1982, Cade, 1975, Cade & Rice, 1980, Otte 1992).

A comunicação acústica nos grilos tem sido alvo de estudos ao longo dos anos, trazendo diversas questões em diferentes campos científicos como evolução, comportamento e até biofísica (e.g., Bennet-Clark, 2003, Desutter-Grandcolas, 1997, Huber *et al.,* 1989). Além disso, as asas e a comunicação acústica em Grylloidea tem sido uma importante fonte de informações tanto taxonômicas como para análises filogenéticas (e.g., Desutter-Grandcolas, 1997, 1999, Desutter-Grandcolas & Robillard, 2004, Gwynne 1995, Jost & Shaw, 2006, Robillard & Desutter-Grandcolas, 2011, Tan *et al.,* 2021).

Os grilos estão entre os organismos mais estudados no campo da Bioacústica. O mecanismo de produção de som em Grylloidea tem sido estudado há pelo menos 50 anos e é bem compreendido pela comunidade científica. A asa anterior (também conhecida como tégmina) direita, nos machos adultos, possui uma veia modificada com pequenos dentes quitinosos em sua face ventral. Essa importante estrutura na sinalização acústica dos grilos é conhecida como veia estridulatória (veia Pós-cubital – PCu) (Desutter-Grandcolas *et al.,* 2017, Schubnel *et al.,* 2019) (Fig. 4). Além disso, a tégmina direita é sobreposta a esquerda em posição de repouso. Já a tégmina esquerda é geralmente uma imagem espelhada da tégmina direita e possui uma região altamente esclerotizada próxima ao final da região da veia estridulatória chamada plectrum (Bennet-Clark, 2003, Elliott & Koch, 1983, Koch *et al.,* 1988, Montealegre-Z *et al.,* 2009). Ao abrir e fechar as tégminas direita e esquerda, a região ventral da veia estridulatória fricciona sobre o plectrum originando vibrações mecânicas que dão origem ao som (Ragge, 1955).

Parar amplificar as vibrações produzidas com a finalidade de propagar o som a longas distâncias, as tégminas possuem regiões membranosas formadas por veias acessórias também conhecidas como ressonadores. Eles são conhecidos como espelho e harpa (composta pelas veias da harpa) (Fig. 4) (Desutter-Grandcolas *et al.,* 2017; Nocke 1971). O conjunto das estruturas da tégmina responsáveis pela produção e propagação do som são chamados de aparato estridulatório (Bethoux & Nél 2001, Desutter-Grandcolas, 1997, 1998, 2003, Schneider *et al.,* 2017).

Apesar do mecanismo de produção de som nos grilos ser bem estabelecido, a compreensão da adaptação e evolução das estruturas envolvidas nessa tarefa estão em constante debate na comunidade científica e estão longe de serem totalmente compreendidos. Para isso, é necessário o aprofundamento em grupos potencialmente modelos onde a diversidade de tégminas possa auxiliar na compressão de sua evolução em um contexto filogenético.

Com grande potencial, Oecanthidae n. status e suas linhagens subordinadas são excelentes candidatas para complementar essas lacunas do conhecimento científico. Essa família de grilos arborícolas está distribuída mundialmente e possui uma grande diversidade morfológica. Principalmente no que se diz respeito as tégminas e seu desenvolvimento. Sua diversidade é representada por grilos com ou sem asas, com asas reduzidas cobrindo apenas o metanoto até longas asas ultrapassando comprimento do corpo (incluindo todos os seus intermediários). Quando as asas são desenvolvidas, elas podem ou não apresentar o aparato estridulatório ou apenas partes específicas dele. Essa diversidade de tipos de tégminas (ou ausência delas) indicam a diversidade de tipos de comunicação dentro desse clado, acústicas ou não (Campos & Desutter-Grandcolas, 2020). A filogenia de Oecanthidae n. status é uma nova ferramenta que possibilita explorar e compreender uma parte desse clado altamente diverso de Grylloidea onde as tégminas e comunicação acústica são uma das suas principais fontes de informação.

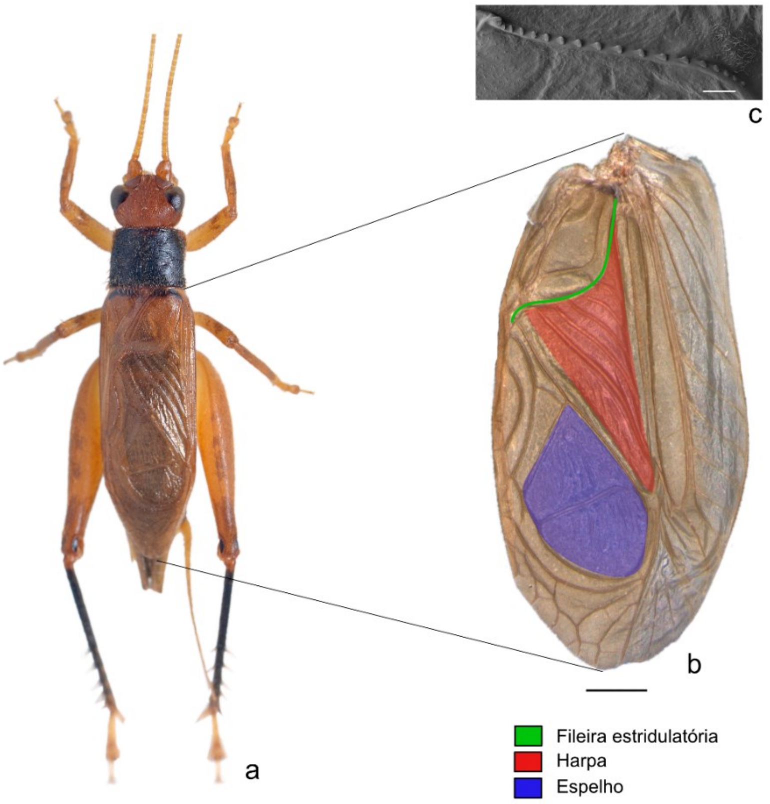


Figura 4. *Diatrypa (Diatrypa) tuberculata*, macho. a-hábito dorsal; b-tégmina direita; c-fileira estridulatória em vista ventral. Escalas: b= 1mm, c= 100µm.

Organização da Tese

Esta tese está dividida em dois capítulos, ambos já em formato de artigo científico. O primeiro capítulo, "**The fifth family of true crickets (Insecta, Orthoptera, Grylloidea), Oecanthidae n. status: phylogenetic relationship and divergence times**" aborda o estudo filogenético do Clado F proposto por Chintauan-Marquier *et al.,* (2016). De acordo com o catálogo Orthoptera Species File (Cigliano *et al.,* 2022), atualmente esse clado faz parte da família Gryllidae incluído no 'Grupo de Subfamílias Podoscirtinae'. Neste capítulo, são feitas análises filogenéticas sob Inferência Bayesiana (IB), Máxima Verossimilhança (MV) e Máxima Parcimônia (MP). Foram utilizados dados morfológicos e moleculares para MV e MP e apenas moleculares para IB, acrescidos do registro fóssil. Os resultados indicam topologias globalmente bem suportadas, confirmando a monofilia do Clado F sensu Chintauan-Marquier *et al.,* (2016). Assim, possibilitando definir uma quinta família de Grylloidea, grupo irmão de Gryllidae n. def.: Oecanthidae n. status. Nós revisamos a definição e a classificação interna de todas as subfamílias incluídas em Oecanthidae n. status, reorganizando-as em supertribos e tribos monofiléticas. Além disso, são listadas as apomorfias de cada nível taxonômico bem como a atualização de suas respectivas diagnoses. Uma chave de identificação é proposta para todos os níveis taxonômicos supragenéricos de Oecanthidae n. status mais os gêneros de Tafaliscinae n. def. n. status. Com os resultados obtidos, uma nova tribo de Hapithidi n. status (Podoscirtinae n. def.) é definida: Phyllogryllini n. tribo. Finalmente, para entender a evolução de Oecanthidae n. status, obtivemos uma árvore calibrada temporalmente através de IB utilizando os dados moleculares e os fósseis disponíveis de Grylloidea.

O segundo capítulo "**Are oecanthid crickets stop singing? The history of characters related to acoustic communication in Oecanthidae (Insecta, Orthoptera, Grylloidea)**", aborda a evolução das tégminas, suas estruturas responsáveis pela sinalização acústica e dos tímpanos na família Oecanthidae n. status baseado nas topologias e tempos de divergência obtidos no capítulo 1. Nesse capítulo foram analisados quatro caracteres das asas anteriores e dois dos tímpanos (interno e externo) através do método de reconstrução de estados ancestrais. Os resultados obtidos mostram a perda da percepção sonora pelos tímpanos tibiais pelo menos seis vezes independentemente na história desse grupo. Além disso, os resultados mostram a perda da sinalização acústica diversas vezes, seja ela relacionada a redução das tégminas, pela perda completa do aparato estridulatório, ou partes dele. Os resultados sugerem o possível sucesso evolutivo desses grilos ao perderem a comunicação acústica e utilizando outros meios para essa finalidade.

Referências

Alexander, R.D. 1962. Evolutionary Change in Cricket Acoustical Communication. *Evolution* 16, 443–467. https://doi.org/doi:10.2307/2406178

Anso, J., Jourdan, H. and Desutter-Grandcolas, L. 2016. Crickets (Insecta, Orthoptera, Grylloidea) from Southern New Caledonia, with descriptions of new taxa. *Zootaxa* 4124, 1. https://doi.org/10.11646/zootaxa.4124.1.1

Bailey, W.J. and others. 1991. *Acoustic behaviour of insects. An evolutionary perspective.* Chapman and Hall Ltd.

Benavides-Lopez, J.L., Ter Hofstede, H. and Robillard, T. 2020. Novel system of communication in crickets originated at the same time as bat echolocation and includes male-male multimodal communication. *The Science of Nature* 107, 9. https://doi.org/10.1007/s00114-020-1666-1

Bennet-Clark, H.C. 2003. Wing resonances in the Australian field cricket *Teleogryllus oceanicus*. *Journal of Experimental Biology* 206, 1479–1496. https://doi.org/10/dbv9xh

Bethoux, O., Nel, A. 2001. Venation pattern of Orthoptera. *Journal of Orthoptera Research* 10, 195–198. https://doi.org/10.1665/1082-6467(2001)010[0195:VPOO]2.0.CO;2

Blanchard, É. 1845. 2 *Histoire des insectes: traitant de leurs moeurs et de leurs métamorphoses en général et comprenant une nouvelle classification fondée sur leurs rapports naturels*. Librairie de F. Didot Frères, Paris, 524 pp.

Bleidorn, C. 2017. Phylogenomics. *Cham: Springer International Publishing*, 173–193.

Burk, T. 1982. Evolutionary Significance of Predation on Sexually Signaling Males. *The Florida Entomologist* 65, 90–104. https://doi.org/10/d82n6j

Cade, W. 1975. Acoustically Orienting Parasitoids: Fly Phonotaxis to Cricket Song. *Science* 190, 1312–1313. https://doi.org/10.1126/science.190.4221.1312

Cade, W.H., Rice, R. 1980. Field Crickets (Orthoptera:Gryllidae) as a Prey of the Toad *Bufo marinus*. *The Canadian Entomologist* 112, 335–336. https://doi.org/10.4039/Ent112335-3

Campos, L.D. de, Desutter-Grandcolas, L. 2020. The Paroecanthini crickets (Orthoptera: Grylloidea: Gryllidae: Oecanthinae) from French Guiana. *Zoosystema* 42, 355–398. https://doi.org/10.5252/zoosystema2020v42a20

Campos, L.D. de, Souza-Dias, P.G.B. de, Desutter-Grandcolas, L., Nihei, S.S. 2021. Colonization of different biomes drove the diversification of the Neotropical Eidmanacris crickets (Insecta: Orthoptera: Grylloidea: Phalangopsidae). *PLOS ONE* 16, e0245325. https://doi.org/10.1371/journal.pone.0245325

Campos, L.D. de, Souza-Dias, P.G.B., Nihei, S.S. 2020. New Brazilian Tafaliscina increase the diversity of this Neotropical cricket clade (Orthoptera: Grylloidea: Gryllidae: Oecanthinae: Paroecanthini). *Zoosystema* 42, 331–353. https://doi.org/10.5252/zoosystema2020v42a19

Chintauan-Marquier, I.C., Legendre, F., Hugel, S., Robillard, T., Grandcolas, P., Nel, A., Zuccon, D., Desutter-Grandcolas, L. 2016. Laying the foundations of evolutionary and systematic studies in crickets (Insecta, Orthoptera): a multilocus phylogenetic analysis. *Cladistics* 32, 54–81. https://doi.org/10.1111/cla.12114

Chopard, L. 1951. Contibuition à l'étude des Gryllides du Congo belge. *Rev. Zool. Bot. Afr.* 44, 297–311.

Chopard, L. 1968. Gryllides. Fam. Gryllidae: Subf. Mogoplistinae, Myrmecophilinae, Scleropterinae, Cachoplistinae Pteroplistinae, Pentacenturinae, Phalangopsinae, Trigonidinae, Eneopierinae; Fam.Oecanthidae, Gryllotalpidae. In: *Orthopterorum Catalogus*. Beier, M., Gravenhage, pp. 213–500.

Cigliano, M.M., Braun, H., Eades, D.C., Otte, D. 2022. Orthoptera Species File. Version 5.0/5.0 [WWW document]. Available from: http://orthoptera.speciesfile.org (January 15, 2022)

Desutter, L. 1987. Structure et évolution du complexe phallique des Gryllidea (Orthoptères) et classification des genres Néotropicaux de Grylloidea. Primière Partie. *Annales de La Société Entomologique de France* 23, 213–239.

Desutter-Grandcolas, L. 1997. A phylogenetic analysis of the evolution of the stridulatory apparatus in true crickets (Orthoptera, Grylloidea). *Cladistics* 13, 101–108.

Desutter-Grandcolas, L. 1998. Broad-frequency modulation in cricket (Orthoptera, Grylloidea) calling songs: two convergent cases and a funtional hypotesis. *Canadian Journal of Zoology* 76, 2148–2163.

Desutter-Grandcolas, L. 2003. Phylogeny and the evolution of acoustic communication in extant Ensifera (Insecta, Orthoptera). *Zoologica Scripta* 32, 525–561. https://doi.org/10.1046/j.1463-6409.2003.00142.x

Desutter-Grandcolas, L., Anso, J., Jourdan, H. 2016. Crickets of New Caledonia (Insecta, Orthoptera, Grylloidea): a key to genera, with diagnoses of extant genera and descriptions of new taxa. *Zoosystema* 38, 405–452. https://doi.org/10.5252/z2016n4a1

Desutter-Grandcolas, L., Jacquelin, L., Hugel, S., Boistel, R., Garrouste, R., Henrotay, M., Warren, B.H., Chintauan-Marquier, I.C., Nel, P., Grandcolas, P., Nel, A. 2017. 3-D imaging reveals four extraordinary cases of convergent evolution of acoustic communication in crickets and allies (Insecta). *Scientific Reports* 7, 1–8. https://doi.org/10.1038/s41598-017-06840-6

Desutter-Grandcolas, L., Robillard, T. 2004. Acoustic evolution in crickets: Need for phylogenetic study and a reappraisal of signal effectiveness. *Anais da Academia Brasileira de Ciencias* 76, 301–315. https://doi.org/10.1590/S0001-37652004000200019

Dong, J., Kergoat, G.J., Vicente, N., Rahmadi, C., Xu, S., Robillard, T. 2018. Biogeographic patterns and diversification dynamics of the genus Cardiodactylus Saussure (Orthoptera, Grylloidea, Eneopterinae) in Southeast Asia. *Molecular Phylogenetics and Evolution* 129, 1–14. https://doi.org/10.1016/j.ympev.2018.06.001

Elliott, C.J.H., Koch, U.T. 1983. Sensory feedback stabilizing reliable stridulation in the field cricket Glyllus campestris L. *Animal Behaviour* 31, 887–901. https://doi.org/10.1016/S0003-3472(83)80244-9

Flook, P.K., Rowell, C.H.F. 1997. The Phylogeny of the Caelifera (Insecta, Orthoptera) as Deduced from mtrRNA Gene Sequences. *Molecular Phylogenetics and Evolution* 8, 89–103. https://doi.org/10.1006/mpev.1997.0412

Gerhardt, H.C., Huber, F. 2002. *Acoustic communication in insects and anurans: common problems and diverse solutions*. University of Chicago Press.

Godfray, H.C.J. 2002) Challenges for taxonomy. *Nature* 417, 17–19. https://doi.org/10/cqqnrx

Gorochov, A.V. 2015. Evolution and taxonomic significance of the copulatory apparatus in Ensifera (Orthoptera). Part 2: Male genitalia in Grylloidea. *Zoosystematica Rossica* 24, 31–41. https://doi.org/10.31610/zsr/2015.24.1.31

Gorochov, A.V. 2017. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 11: the tribe Hapithini and other American taxa. *Zoosystematica Rossica* 26, 11–106.

Grant, P.R., Grant, B.R., Huey, R.B., Johnson, M.T.J., Knoll, A.H., Schmitt, J. 2017. Evolution caused by extreme events. *Philosophical Transactions of the Royal Society B: Biological Sciences* 372, 20160146. https://doi.org/10.1098/rstb.2016.0146

Gwynne, D.T. 1995. Phylogeny of the Ensifera (Orthoptera): A Hypothesis Supporting Multiple Origins of Acoustical Signalling, Complex Spermatophores and Maternal Care in Crickets, Katydids, and Weta. *Journal of Orthoptera Research* 4, 203–218. https://doi.org/10.2307/3503478

Hedwig, B. 2014. 1 *Insect hearing and acoustic communication*. Springer, Cambridge, 222 pp.

Huber, F., Moore, T.E., Loher, W. 1989. *Cricket Behavior and Neurobiology*. 124 pp.

Jost, M.C., Shaw, K.L. 2006. Phylogeny of Ensifera (Hexapoda: Orthoptera) using three ribosomal loci, with implications for the evolution of acoustic communication. *Molecular Phylogenetics and Evolution* 38, 510–530. https://doi.org/10.1016/j.ympev.2005.10.004

Koch, U.T., Elliott, C.J.H., Schäffner, K.-H., Kleindienst, H.-U. 1988. The mechanics of stridulation of the cricket *Gryllus campestris*. *Journal of Comparative Physiology A* 162, 213–223. https://doi.org/10.1007/BF00606086

Legendre, F., Robillard, T., Song, H., Whiting, M.F., Desutter-Grandcolas, L. 2010. One hundred years of instability in ensiferan relationships. *Systematic Entomology* 35, 475–488. https://doi.org/10.1111/j.1365-3113.2009.00519.x

Lobregat, G., Gechel Kloss, T., Peixoto, P.E.C., Sperber, C.F. 2019. Fighting in rounds: males of a neotropical cricket switch assessment strategies during contests. *Behavioral Ecology*, 1–9. https://doi.org/10.1093/beheco/arz005

Mariño-Pérez, R., Song, H. 2018. Phylogeny of the grasshopper family Pyrgomorphidae (Caelifera, Orthoptera) based on morphology. *Systematic Entomology* 43, 90–108. https://doi.org/10.1111/syen.12251

Montealegre-Z, F., Windmill, J.F.C., Morris, G.K., Robert, D. 2009. Mechanical phase shifters for coherent acoustic radiation in the stridulating wings of crickets: the plectrum mechanism. *The Journal of experimental biology* 212, 257–269. https://doi.org/10.1242/jeb.022731

Nel, A. 2021. Impact of the choices of calibration points for molecular dating: a case study of Ensifera. Palaeoentomology. 4. doi:10.11646/palaeoentomology.4.3.9

Nocke, H. 1971. Biophysik der Schallerzeugung durch die Vorderflügel der Grillen. *Zeitschrift für vergleichende Physiologie* 74, 272–314.

Otte, D. 1992. Evolution of Cricket Songs. *Journal of Orthoptera Research*, 25–49. https://doi.org/10.2307/3503559

Otte, D. 1994a. *Orthoptera Species File Numer 1*. The Orthopterists' Society, Philadelphia, 142 pp.

Otte, D. 1994b. *The crickets of Hawaii: origin, systematics, and evolution*. The Orthopterists' Society, Philadelphia, 396 pp.

Otte, D., Alexander, R.D. 1983. The Australian crickets (Orthoptera: Gryllidae). *The Australian crickets (Orthoptera: Gryllidae).*

Otte, D., Pérez-Gelabert, D.E. 2009. *Caribbean crickets*. Orthopterists' Society.

Pollack, G.S. 2010. Acoustic Communication in Insects: Neuroethology. *Encyclopedia of Animal Behavior* 9, 1–6. https://doi.org/10.1016/B978-0-08-045337-8.00157-1

Ragge, D.R. 1955. *The wing-venation of the Orthoptera Saltatoria, with notes on Dictyopteran wing-venation*. British Museum (Natural History), London, 160 pp.

Robillard, T., Desutter-Grandcolas, L. 2004. Phylogeny and the modalities of acoustic diversification in extant Eneopterinae (Insecta, Orthoptera, Grylloidea, Eneopteridae). *Cladistics* 20, 271–293. https://doi.org/10.1111/j.1096-0031.2004.00025.x

Robillard, T., Desutter-grandcolas, L. 2011. Evolution of calling songs as multicomponent signals in crickets (Orthoptera : Grylloidea : Eneopterinae). 50, 627–672. https://doi.org/10.1163/000579511X572044

Saussure, H. de 1874. *Mission scientifique au Mexique et dans l'Amerique centrale. É tudes sur Les Myriapodes et Les Insects*. Imprimerie Impériale, Paris, 211 pp.

Saussure, H. de 1897. 1 *Biologia Centrali-Americana. Insecta. Orthoptera.* 285 pp.

Schneider, E.S., Römer, H., Robillard, T., Schmidt, A.K.D. 2017. Hearing with exceptionally thin tympana: Ear morphology and tympanal membrane vibrations in eneopterine crickets. *Scientific Reports* 7. https://doi.org/10.1038/s41598-017-15282-z

Schubnel, T., Desutter-Grandcolas, L., Legendre, F., Prokop, J., Mazurier, A., Garrouste, R., Grandcolas, P., Nel, A. 2019. To be or not to be: postcubital vein in insects revealed by microtomography. *Systematic Entomology*, 1–10. https://doi.org/10.1111/syen.12399

Scudder, S.H. 1897. *Guide to the genera and classification of the North American Orthoptera found north of Mexico*. EW Wheeler.

Song, H., Amédégnato, C., Cigliano, M.M., Desutter-Grandcolas, L., Heads, S.W., Huang, Y., Otte, D., Whiting, M.F. 2015. 300 million years of diversification: elucidating the patterns of orthopteran evolution based on comprehensive taxon and gene sampling. *Cladistics* 31, 621–65. https://doi.org/10.1111/cla.12116

Song, H., Béthoux, O., Shin, S., Donath, A., Letsch, H., Liu, S., McKenna, D.D., Meng, G., Misof, B., Podsiadlowski, L., Zhou, X., Wipfler, B., Simon, S. 2020. Phylogenomic analysis sheds light on the evolutionary pathways towards acoustic communication in Orthoptera. *Nature Communications* 2020, 4939. https://doi.org/10.1038/s41467-020-18739-4

Tan, M.K., Malem, J., Legendre, F., Dong, J., Baroga-Barbecho, J.B., Yap, S.A., Wahab, R. bin H.A., Japir, R., Chung, A.Y.C., Robillard, T. 2021. Phylogeny, systematics and evolution of calling songs of the Lebinthini crickets (Orthoptera, Grylloidea, Eneopterinae), with description of two new genera. *Systematic Entomology* 46, 1060–1087. https://doi.org/10/gmsd9r

Vicente, N., Kergoat, G.J., Dong, J., Yotoko, K., Legendre, F., Nattier, R., Robillard, T. 2017. In and out of the Neotropics: historical biogeography of Eneopterinae crickets. *Journal of Biogeography* 44, 2199–2210. https://doi.org/10.1111/jbi.13026

Objetivos

Os objetivos da presente tese são:

-Realizar análise filogenética, através de dados moleculares e morfológicos, da família Oecanthidae n. status com base no “Clado F” proposto por Chintauan-Marquier *et al.* (2016).

-Definir e organizar Oecanthidae n. status, e os grupos que a compõe, através de diagnoses, figuras e lista de gêneros baseadas nos resultados das análises filogenéticas.

-Confeccionar uma chave de identificação para os táxons supragenéricos de Oecanthidae n. status.

-Confeccionar uma chave de identificação para os gêneros de Tafaliscinae n. def. n. status.

-Estimar os tempos de divergência de Oecanthidae n. status e seus táxons supragenéricos.

-Realizar reconstrução de estados ancestrais para caracteres relacionados a comunicação acústica em Oecanthidae n. status.

Capítulo 1

The fifth family of true crickets (Insecta, Orthoptera, Grylloidea), Oecanthidae n. status: phylogenetic relationship and divergence times

Abstract

Crickets are frequently used as a model in several areas of science, like acoustic communication, behavior, and neurobiology. However, only a few of these studies are in an evolutionary frame due to the limited number of phylogenetic hypotheses for true crickets. We present a phylogenetic hypothesis for a new family of crickets, sister-group of Gryllidae n. def.: Oecanthidae n. status. The phylogenetic analyses are based on molecular (fragments of 12S, 16S, 18S, 28SA, and 28SD) and morphological data for likelihood and parsimony criteria and molecular data for divergence times estimation (Bayesian Inference). We used 107 terminals from all biogeographic regions and six fossils for the time calibration of the tree. All analyses resulted in Oecanthidae n. status with four subfamilies: Euscyrtinae, Oecanthinae n. def., Podoscirtinae n. def., and Tafaliscinae n. def., n. status. Based on our results, we revise the definition and internal classification of the subfamilies, supertribes (proposed here), and tribes. Phyllogryllini n. tribe is defined. We also update their diagnoses, list the genera of the tribes, and list their apomorphies. We propose an identification key for all taxonomic ranges of Oecanthidae n. status plus all genera of Tafaliscinae n. def., n. status. Finally, we discuss the phylogenetic relationships of Oecanthidae n. status (outgroup and internal nodes), their divergence times, habitat diversity, and the importance of ovipositor diversity in this clade.

Keywords: tree crickets, diversification, morphology, molecular, Systematics, calibration

Introduction

Crickets (Orthoptera, Gryllidea) are frequently used as models for studies in acoustic communication (Bailey, 1991; Gerhardt and Huber, 2002), neurobiology (Hedwig, 2014; Pollack *et al.*, 2016), and behavior (Gwynne and Morris, 1983; Huber *et al.*, 1989; Matthews and Matthews, 2009). These insects are also well-known for their very high speciation rates, as highlighted by their diversity on islands (Otte and Alexander, 1983; Otte, 1994; Shaw, 2002; Ritchie and Garcia, 2005). By contrast, very few studies have analyzed cricket evolution in a wide taxonomic scope, which can be due first to a global deficit of phylogenies of cricket clades, and second to a lack of data on cricket's natural history in the wild.

Crickets have been included in studies with a broad taxonomic sampling of Orthoptera, with a relatively small number of terminals (Song *et al.*, 2015, 2020). Currently, only one large-scale phylogenetic study is dedicated to Gryllidea (Chintauan-Marquier *et al.*, 2016). Sanno *et al.* (2021) studied a limited sample of mitogenomes of the whole cricket clades, and their results confirmed those of Chintauan-Marquier et al. (2016). Other works focused on a limited geographical range (Nattier *et al.*, 2011; He *et al.*, 2020) or lower taxonomic levels, such as subfamilies (Robillard and Desutter-Grandcolas, 2004, 2006; Vicente *et al.*, 2017), tribes (Tan *et al.*, 2021), and genera (Huang *et al.*, 2000; Desutter-Grandcolas and Robillard, 2003; Mendelson and Shaw, 2005; Shen *et al.*, 2020; Campos *et al.*, 2021), which represent a selected, biased sample of cricket diversity. Consequently, phylogenetic hypotheses for true crickets (Orthoptera, Grylloidea) are still scarce, which prevents advances in evolutionary studies of this emblematic group of organisms.

Despite a large number of time-calibrated trees available in insect literature, only a few include Orthoptera (Song *et al.*, 2015, 2020), and fewer focus on crickets. In fact, dated trees are available only for Eneopterinae (Gryllidae) and its subordinate taxa (Vicente *et al.*, 2017; Dong *et al.*, 2018; Tan *et al.*, 2021). This subfamily is becoming a new model in evolutionary biology, thanks to combined advances in taxonomy, phylogeny, and observations in the field (Robillard, 2021). But even these studies suffer from the still incipient fossil record of Grylloidea (see Vicente *et al.*, 2017), with few complete fossils, often misclassified due to the lack of phylogeny-based taxonomy with apomorphic characters for the clades (Desutter-Grandcolas *et al.*, 2021).

Chintauan-Marquier *et al.* (2016)'s phylogenetic tree of Grylloidea, based on 205 taxa from all world regions (except the poles) and six molecular markers (mitochondrial and nuclear), supports four main clades in this superfamily, which were proposed as four families, i.e., Mogoplistidae Costa, 1855; Trigonidiidae Saussure, 1874; Phalangopsidae Blanchard, 1845; and Gryllidae Laicharting, 1781. The family Gryllidae was divided into two clades, Clade F and Clade G. This classification has been largely adopted, without, however, a complete congruence between phylogeny and taxonomy (Cigliano *et al.*, 2022).

We undertook a detailed study of the 'Clade F' of Chintauan-Marquier *et al.* (2016). In the taxonomy used by Cigliano *et al.* (2022), the clade F is part of the Gryllidae family, which comprises a 'subfamily group Gryllinae' (with six extant subfamilies), a 'subfamily group Podoscirtinae' (including four subfamilies: Euscyrtinae Gorochov, 1985, Hapithinae Gorochov, 1986, Pentacentrinae Saussure, 1878 and Podoscirtinae Saussure, 1878) and two separate subfamilies (Eneopterinae Saussure, 1874 and Oecanthinae Blanchard, 1845). By contrast, according to Chintauan-Marquier *et al.* (2016), the clade F gathers the Oecanthinae and only three subfamilies of the 'subfamily group Podoscirtinae', i.e., Euscyrtinae, Hapithinae, and Podoscirtinae; all the other subfamilies were included in the clade G or, for at least one of them, in another cricket family.

Chintauan-Marquier's et al. (2016) clade F is thus unrecognized as a taxon in the present state of cricket taxonomy. Moreover, it has not yet been tested or defined by a clear set of synapomorphies, a confusion also shared with its sister clade G. Clade F presents a remarkable morphological diversity combined with a large diversity of habitats, mostly related to plant stratification, with species inhabiting grasses, shrubs, short and tall trees, in forests or open areas, in the canopy or the understorey (Otte and Alexander, 1983; Otte, 1994; Otte and Pérez-Gelabert, 2009; Campos and Desutter-Grandcolas, 2020; Campos *et al.*, 2020). With worldwide distribution, these insects are also diverse in their body sizes (~10mm – ~40mm), forewing morphology with various acoustic structures (from complete and functional to absent, with all intermediate stages), forewing development (from aptery to long wings covering the entire body), and ovipositor shapes (Otte and Alexander, 1983; Otte and Pérez-Gelabert, 2009; Anso *et al.*, 2016; Gorochov, 2017; Campos and Desutter-Grandcolas, 2020).

Explaining the diversity and evolution of cricket's Clade F will provide an excellent model for evolutionary studies on behavior, bioacoustics, biogeography, and trait evolution, not to mention insights into the influence of past environmental events on clade diversification (Grant *et al.*, 2017). In addition, the morphological diversity of these crickets, combined with a robust phylogenetic framework, will provide essential clues to understand their affinity to plant stratification and how the use of different habitats has shaped their evolutionary success.

In the present paper, we reconstruct a phylogenetic hypothesis of a large set of taxa (107) of clades F and G *sensu* Chintauan-Marquier et al.'s (2016) clades F + G under Bayesian Inference (BI), Maximum Likelihood (ML), and Maximum Parsimony (MP) criteria. The analyses are based on molecular and morphological data, except for BI, which used only molecular data. Our results confirm the monophyly of clade F and justify the definition of a fifth family for true crickets: the Oecanthidae n. status (Fig. 1), sister of the family Gryllidae n. def. To further understand the evolution of the family, we estimated a time-calibrated tree of Oecanthidae n. status under BI using the available fossils of Grylloidea. In addition, we revise the definition and internal classification of all subfamilies included in Oecanthidae n. status, reorganizing them into monophyletic supertribes and tribes. Then, we list the apomorphies for each clade and update their diagnoses. Finally, we propose an identification key for all taxonomic ranges plus the genera of Neotropical Tafaliscinae n.def., n. status. A new tribe is defined in the Hapithidi n. status (Podoscirtinae), i.e., the Phyllogryllini Campos n. tribe.

The resultant monophyletic subfamilies/supertribes/tribes prove congruent with main biogeographic regions and show coherent patterns of habitat specialization, which is not the case with present-day Gryllidae taxonomy. Tafaliscinae n. def., n. status and Diatrypidi n. status (Oecanthinae) are exclusively neotropical, Hapithidi n. status (Podoscirtinae) are distributed in the Neotropics and south of Nearctic Region, while Podoscirtidi n. status (Podoscirtinae) are distributed worldwide, except in the Neotropical Region. Euscyrtinae are distributed in the Afrotropics, Australasia, Indo-Malayan, with some representatives in the Neotropical Region. Finally, Oecanthidi n. status (Oecanthinae n. def.) are present worldwide.

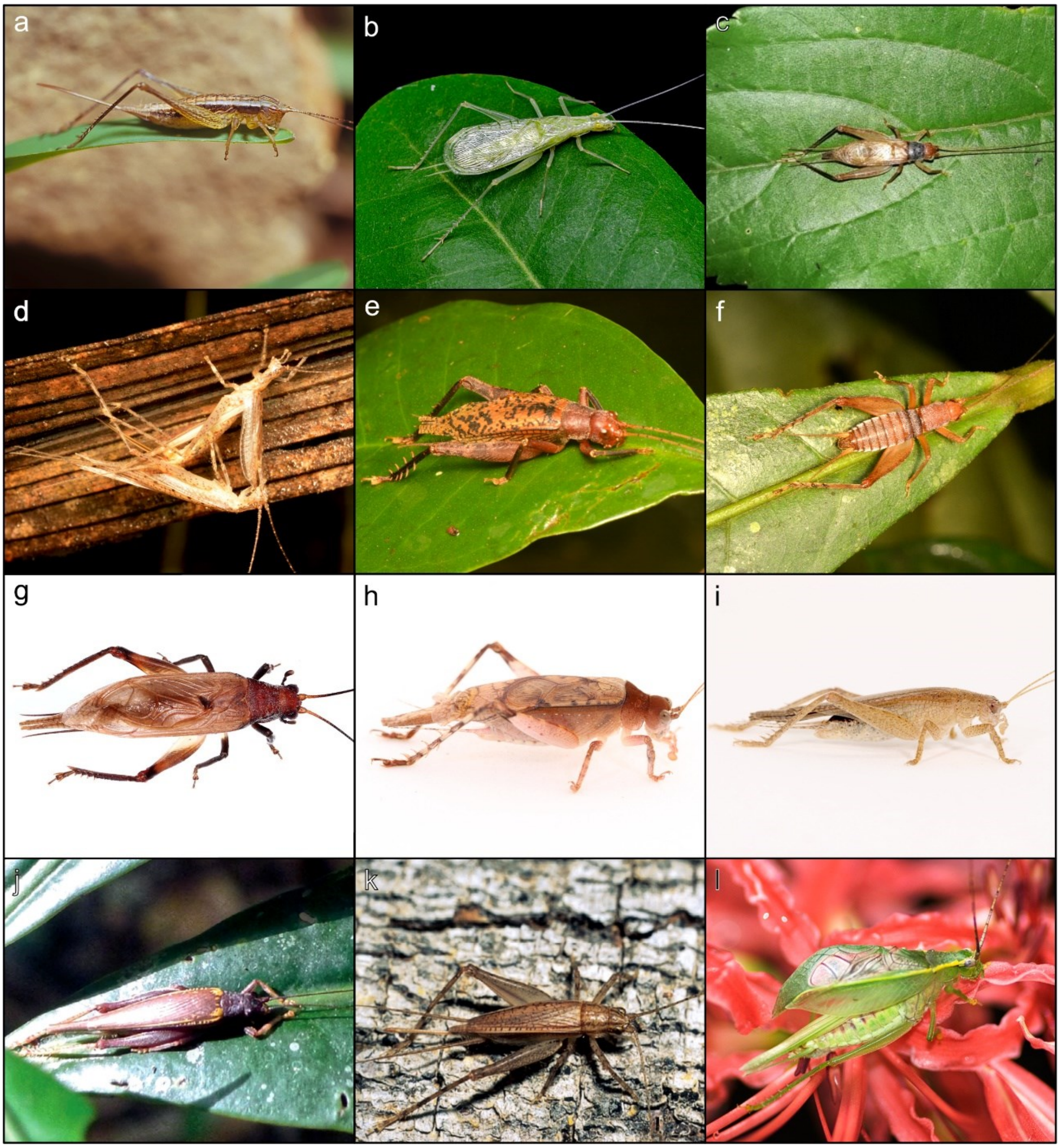


Figure 1. Diversity of Oecanthidae n. status: a-*Proturana subapterus*, female (Euscyrtinae) (photo: Laure Desutter-Grandcolas); b-*Oecanthus* sp., male (Oecanthinae n. def., Oecanthidi n. status, Oecanthini) (photo: Marcos Fianco); c-*Diatrypa* sp., male (Oecanthinae n. def., Diatrypidi n. status) (photo: Neucir Szinwelski); d-*Stenoecanthus planixiphus*, male and female mating (Oecanthinae n. def.) (photo: Sylvain Hugel); e-*Tafalisca hugeli*, male (Tafaliscinaen. Def. n. status, Tafaliscidi n. status) (photo: Sylvain Hugel); f-*Apterotrypa mitarakensis*, male (Tafaliscinae, Paroecanthidi n. status, Neometrypini) (photo: Sylvain Hugel); g-*Angustitrella* sp., male (Tafaliscinae n. def. n. status, Paroecanthidi n. status, Paroecanthini) (photo: Pedro Souza-Dias); h-*Phyllogryllus velutinus*, male (Podoscirtinae n. def., Hapithidi n. status, Phyllogryllini n. tribe) (photo: Lucas Denadai de Campos); i-*Cearacesa* sp., male (Podoscirtinae n. def., Hapithidi n. status, Cearacesaini) (photo: Lucas Denadai de Campos); j-*Matuanus caledonicus*, male (Podoscirtinae n. def., Podoscirtidi n. status, Aphonoidini) (photo: Hervé Jourdan); k-*Adenopterus* sp., female (Podoscirtinae n. def., Podoscirtidi n. status, Aphonoidini) (photo: Phillipe Grandcolas); l-*Trulajlia hibinonis*, male (Podoscirtinae, Podoscirtidi n. status, Truljaliini n. status) (photo: Masaki Ikeda, Wikipedia).

Material and Methods

Taxon sampling

For the phylogenetic analyses, 107 terminals (17 outgroup, 90 ingroup) were selected (Table 1), based on clades F+G proposed by Chintauan-Marquier *et al.* (2016) and on molecular and morphological data availability. All selected specimens are documented for three or four molecular markers (sequenced by us or from GenBank, see infra). *Cranistus colliurides* Stål (Trigonidiidae, Trigonidiinae) was used to root the trees. The sequenced and examined material belongs to the following institutions: Laboratório de Insetos do Departamento de Zoologia da UNESP de Botucatu, Botucatu (BOTU), Muséum national d'Histoire naturelle, Paris (MNHN), Museu de Zoologia da Universidade de São Paulo, São Paulo (MZSP), and Instituto Nacional de Pesquisas da Amazônia Manaus, (INPA). Distributional data were compiled from Orthoptera Species File (OSF) (Cigliano *et al.*, 2022), except for taxa used herein. The definitions of areas follow Dinerstein *et al.* (2017).

Table 1. Sampled taxa for molecular data. Accession numbers are indicated for GenBank sequences. Realms: Afr-Afrotropic, Aus-Australasia, Ind-Indo-Malay, Neo-Neotropical, Oce-Oceania, Pal-Paleotropical *sequences obtained at *Laboratório de Evolução Molecular* (LEM/USP); ** sequences obtained at *Service de Systématique Moléculaire* (SSM/MNHN); - missing data.

Taxon	**Molecular code**	**Subfamily**	**Realm**	**Locality**	**12S**	**16S**	**18S**	**28SA**	**28SD**	**Morphology characters**
Absonemobius guyanensis	LDG 047	Nemobiinae	Neo	French Guiana, Arataye	KR903868	-	KR904058	KR903497	KR902996	193
Cranistus colliurides	DNA 23	Trigonidiinae	Neo	Brazil, Itatiaia	OM501650*	OM501746*	OM501898*	OM501816*	OM501971*	188
Aracamby sp. Cantareira	DNA 02	Luzarinae	Neo	Brazil, São Paulo	OM501635*	OM501731*	OM501883*	OM501801*	OM501961*	190
Eidmanacris endophallica	PSD 404	Luzarinae	Neo	Brazil, Serra dos Orgãos	OM501715*	-	OM501954*	OM501878*	OM502005*	196
Endecous sp. Cantareira	DNA 03	Luzarinae	Neo	Brazil, São Paulo	OM501636*	OM501732*	OM501884*	OM501802*	OM501962*	191
Cardiodactylus novaeguineae	CnoPe	Eneopterinae	Aus	Vanuatu, Espiritu Santo	JF972506	JF972521	JF972537	KR903500	KR902998	197
Eneoptera surinamensis	DNA 26	Eneopterinae	Neo	Brazil, Camacan	OM501653*	OM501749*	OM501900*	-	OM501972*	197
Ligypterus linharensis	DNA 27	Eneopterinae	Neo	Brazil, Camacan	OM501654*	OM501750*	OM501901*	OM501819*	-	197
Xenogryllus eneopteroides	XenAC	Eneopterinae	Afr	Central African Republic	KR904023	KR903829	KR904205	KR903670	KR903148	197
Anurogryllus sp. Itatiaia	DNA 45	Gryllinae	Neo	Brazil, Itatiaia	OM501667*	OM501763*	OM501913*	OM501832*	-	179
Eumodicogryllus bordigalensis	LDG 174	Gryllinae	Neo	The Netherlands	KR903962	KR903785	KR904149	KR903622	KR903100	141
Gryllodes sigillatus	LDG 042	Gryllinae	Afr	Comoros, Anjouan	KR903863	KR903701	KR904053	KR903529	KR903027	197
Gryllus sp. Veredas	DNA 30	Gryllinae	Neo	Brazil, Veredas	OM501657*	OM501753*	OM501904*	OM501822*	OM501974*	149
Zebragryllus nouragui	LDG 094	Gryllinae	Neo	French Guiana, Arataye	KR903900	KR903729	KR904088	KR903565	KR903055	197
Creolandreva crepitans	LDG 138	Landrevinae	Afr	Mauritius	KR903931	KR903758	KR904118	KR903592	KR903079	197
Odontogryllus setosus	LDG 100	Landrevinae	Neo	French Guiana, Arataye	KR903905	KR903734	KR904093	-	-	196
Xulavuna n.sp.	DNA 69	Landrevinae	Neo	Brazil, Contraguaçu	OM501683*	OM501779*	OM501929*	OM501848*	-	181
Euscyrtus aff. bipunctatus	LDG 161	Euscyrtinae	Aus	Vanuatu, Espiritu Santo	KR903951	KR903775	KR904138	KR903492	KR902988	188
Euscyrtus bivittatus	LDG 187	Euscyrtinae	Afr	Mauritius	KR903969	KR903791	KR904155	KR903629	-	143
Proturana subapterus	LDG 163	Euscyrtinae	Aus	New Caledonia	KR903953	-	KR904140	KR903613	KR903094	188
Diatrypa (Diatrypa) sp. Sta.Teresa	DNA 16	Oecanthinae	Neo	Brazil, Santa Teresa	OM501643*	OM501739*	OM501891*	OM501809*	OM501967*	180
Diatrypa (Diatrypa) tuberculata	DNA 17	Oecanthinae	Neo	Brazil, Itatiaia	OM501644*	OM501740*	OM501892*	OM501810*	OM501968*	197

Table 1. Continued. Sampled taxa for molecular data. Accession numbers are indicated for GenBank sequences. Realms: Afr-Afrotropic, Aus-Australasia, Ind-Indo-Malay, Neo-Neotropical, Oce-Oceania, Pal-Paleotropical *sequences obtained at *Laboratório de Evolução Molecular* (LEM/USP); ** sequences obtained at *Service de Systématique Moléculaire* (SSM/MNHN); - missing data.

Taxon	**Molecular code**	**Subfamily**	**Realm**	**Locality**	**12S**	**16S**	**18S**	**28SA**	**28SD**	**Morphology characters**
Diatrypa (Latispeculum) sp. Manaus	DNA 51	Oecanthinae	Neo	Brazil, Manaus	OM501672*	OM501768*	OM501918*	OM501837*	OM501980*	189
Diatrypa (Latispeculum) aff. brunnea	DNA 38	Oecanthinae	Neo	Brazil, Jau	OM501661*	OM501757*	OM501907*	OM501826*	OM501975*	180
Diatrypini Black n. gen?	DNA 47	Oecanthinae	Neo	Brazil, Igrapiúna	OM501668*	OM501764*	OM501914*	OM501833*	OM501978*	-
Neoxabea brevipes	DNA 48	Oecanthinae	Neo	Brazil, Salesópolis	OM501669*	OM501765*	OM501915*	OM501834*	-	197
Neoxabea sp. GUY	LDG 556	Oecanthinae	Neo	French Guiana, Aratarye	OM501702**	-	OM501948**	OM501866**	OM501999**	105
Oecanthus chopardi	LDG 173	Oecanthinae	Afr	Yemen, Socotra	-	KR903784	KR904148	KR903493	KR902990	-
Oecanthus lineolatus	DNA 65	Oecanthinae	Neo	Brazil, São Lourenço do Sul	OM501682*	OM501778*	OM501928*	OM501847*	-	197
Oecanthus pallidus	DNA 40	Oecanthinae	Neo	Brazil, Botucatu	OM501663*	OM501759*	OM501909*	OM501828*	OM501976*	197
Oecanthus sp. BRA	LDG 538	Oecanthinae	Neo	Brazil, Linhares	OM501696**	OM501788**	OM501943**	OM501861**	-	-
Oecanthus sp. COM	LDG 045	Oecanthinae	Afr	Comoros, Anjouan	KR903866	KR903704	KR904056	KR903532	KR903030	147
Prognathogryllus pihea	LDG 388	Oecanthinae	Oce	Hawaii	OM501692**	OM501785**	OM501938**	OM501856**	OM501990**	146
Thaumatogryllus variegatus	LDG 389	Oecanthinae	Oce	Hawaii	OM501693**	-	OM501939**	OM501857**	OM501991**	183
Adenopterus sp.1	LDG 631	Podoscirtinae	Aus	New Caledonia	OM501706**	-	OM501952**	OM501870**	OM502003**	-
Adenopterus sp.2	LDG 637	Podoscirtinae	Aus	New Caledonia	OM501707**	OM501793**	OM501953**	-	OM502004**	-
A. (Aphonomorphus) aff. montanus Jau	DNA 37	Podoscirtinae	Neo	Brazil, Jau	OM501660*	OM501756*	-	OM501825*	-	180
A.(Euaphonus) sp. GUY	LDG 179	Podoscirtinae	Neo	French Guiana, Aratarye	KR903965	KR903787	-	KR903624	-	180
Archenopterus adamantus	LDG 492	Podoscirtinae	Aus	New Caledonia	-	-	OM501941**	OM501859**	OM501993**	180
Archenopterus sp.	LDG 218	Podoscirtinae	Aus	New Caledonia	OM501686**	-	OM501932**	OM501850**	OM501987**	-
Archenopterus sp. NCAL	LDG 200	Podoscirtinae	Aus	New Caledonia	OM501685**	OM501781**	OM501931**	-	OM501986**	180
Calscirtus amoa	LDG 219	Podoscirtinae	Aus	New Caledonia	KR903993	-	KR904176	KR903642	KR903120	188
Calscirtus sp.	LDG 629	Podoscirtinae	Aus	New Caledonia	OM501704**	OM501792**	OM501950**	OM501868**	OM502001**	-
Cearacesa cearensis	DNA 25	Podoscirtinae	Neo	Brazil, Porto Seguro	OM501652*	OM501748*	OM501899*	OM501818*	-	197
Cearacesa nova	DNA 50	Podoscirtinae	Neo	Brazil, Gameleira do Assuará	OM501671*	OM501767*	OM501917*	OM501836*	-	197
Freyrius sp. COM	LDG 096	Podoscirtinae	Afr	Comoros, Anjouan	KR903901	KR903730	KR904089	KR903566	KR903056	189

Table 1. Continued. Sampled taxa for molecular data. Accession numbers are indicated for GenBank sequences. Realms: Afr-Afrotropic, Aus-Australasia, Ind-Indo-Malay, Neo-Neotropical, Oce-Oceania, Pal-Paleotropical *sequences obtained at *Laboratório de Evolução Molecular* (LEM/USP); ** sequences obtained at *Service de Systématique Moléculaire* (SSM/MNHN); - missing data.

Taxon	**Molecular code**	**Subfamily**	**Realm**	**Locality**	**12S**	**16S**	**18S**	**28SA**	**28SD**	**Morphology characters**
Gryllophyllus sp. GDP	LDG 043	Podoscirtinae	Neo	Guadeloupe	OM501684**	OM501780**	OM501930**	OM501849**	OM501985**	189
Hapithus sp. MEX	LDG 204	Podoscirtinae	Neo	Mexico, Chiapas	KR903982	-	KR904166	KR903635	-	188
Matuanus aff. mirabilis	LDG 630	Podoscirtinae	Neo	New Caledonia	OM501705**	-	OM501951**	OM501869**	OM502002**	189
Mistchenkoana sp. Santo	LDG 160	Podoscirtinae	Aus	Vanuatu, Espiritu Santo	KR903950	KR903774	KR904137	KR903611	KR903092	188
Munda aff. asyrinx	LDG 131	Podoscirtinae	Ind	Indonesia, Java	KR903927	KR903754	KR904114	KR903588	KR903076	187
Phyllogryllus pipilans	lbr 408	Podoscirtinae	Neo	French Guiana, Papaichton	OM501714**	OM501799**	OM501960**	OM501877**	-	149
Phyllogryllus sp. Veredas	DNA 49	Podoscirtinae	Neo	Brazil, Veredas	OM501670*	OM501766*	OM501916*	OM501835*	OM501979*	99
Phyllogryllus velutinus	DNA 60	Podoscirtinae	Neo	Brazil, Belterra	OM501678*	OM501774*	OM501924*	OM501843*	-	197
Pixipterus sp. NCAL	LDG 543	Podoscirtinae	Aus	New Caledonia	OM501697**	OM501789**	OM501944**	-	OM501995**	189
POD n. gen.? Santo	LDG 269	Podoscirtinae	Aus	Vanuatu, Espiritu Santo	OM501689**	OM501784**	OM501935**	OM501853**	-	112
Podo *Archenopterus*	LDG 628	Podoscirtinae	Aus	New Caledonia	OM501703**	OM501791**	OM501949**	OM501867**	OM502000**	-
Prozvenella bangalorensis	LDG 216	Podoscirtinae	Ind	India, Karnataka	KR903991	-	KR904174	KR903641	KR903118	190
Somnambula livida	LDG 222	Podoscirtinae	Neo	French Guiana, Saint-Jean-du-Maroni	KR903996	KR903805	KR904179	KR903645	KR903123	141
Somnambula ucayali	DNA 52	Podoscirtinae	Neo	Brazil, Manaus	OM501673*	OM501769*	OM501919*	OM501838*	OM501981*	197
Sonotrella (Calyptotrella) bispinosa	LDG 268	Podoscirtinae	Ind	Indonesia	OM501688**	OM501783**	OM501934**	OM501852**	OM501989**	172
Stenogryllus sp. GDP	lbr 397	Podoscirtinae	Neo	Guadeloupe	OM501712**	OM501797**	OM501958**	OM501873**	OM502008**	-
Stenogryllus sp. MGA	LDG 459	Podoscirtinae	Neo	Marie-Galante	OM501694**	OM501786**	OM501940**	OM501858**	OM501992**	197
Taroba elephantina	DNA 24	Podoscirtinae	Neo	Brazil, Foz do Iguaçu	OM501651*	OM501747*	-	OM501817*	-	197
Truljalia hibinonis	LDG 234	Podoscirtinae	Ind	China, Padang	OM501687**	KR903809	KR904182	KR903494	KR902992	189
Adenophallusia legendrei	LDG 554	Tafaliscinae	Neo	French Guiana, Mitaraka	OM501700**	-	OM501946**	OM501864**	-	197
Amblyrhethus n.sp.1 Chap.Gui.	DNA 07	Tafaliscinae	Neo	Brazil, Chapada dos Guimarães	OM501639*	OM501735*	OM501887*	OM501805*	OM501964*	180
Amblyrhethus n.sp.2 Linhares	DNA 54	Tafaliscinae	Neo	Brazil, Linhares	OM501675*	OM501771*	OM501921*	OM501840*	OM501983*	180
Amblyrhethus sp. Alagoas	DNA 53	Tafaliscinae	Neo	Brazil, Satuba	OM501674*	OM501770*	OM501920*	OM501839*	OM501982*	104
Angistitrella vicina 1	LDG 555	Tafaliscinae	Neo	French Guiana, Mitaraka	OM501701**	-	OM501947**	OM501865**	OM501998**	197

Table 1. Continued. Sampled taxa for molecular data. Accession numbers are indicated for GenBank sequences. Realms: Afr-Afrotropic, Aus-Australasia, Ind-Indo-Malay, Neo-Neotropical, Oce-Oceania, Pal-Paleotropical *sequences obtained at *Laboratório de Evolução Molecular* (LEM/USP); ** sequences obtained at *Service de Systématique Moléculaire* (SSM/MNHN); - missing data.

Taxon	Molecular code	Subfamily	Realm	Locality	12S	16S	18S	28SA	28SD	Morphology characters
Angustitrella aff. *vicina* 1 GUY	LDG 092	Tafaliscinae	Neo	French Guiana, Nouragues	KR903899	KR903728	KR904087	KR903564	KR903054	103
Angustitrella mataraku	DNA 28	Tafaliscinae	Neo	Brazil, Porto Velho	OM501655*	OM501751*	OM501902*	OM501820*	-	197
Angustitrella picipes	DNA 57	Tafaliscinae	Neo	Brazil, Linhares	OM501676*	OM501772*	OM501922*	OM501841*	OM501984*	180
Angustitrella sp. Guy	LDG 091	Tafaliscinae	Neo	French Guiana, Arataye	KR903898	KR903727	KR904086	KR903563	KR903053	103
Angustitrella sp. Guy	lbr 015	Tafaliscinae	Neo	French Guiana, Papaichton	OM501708**	OM501794**	-	OM501871**	-	-
Angustitrella sp. Manaus	DNA 34	Tafaliscinae	Neo	Brazil, Manaus	OM501659*	OM501755*	OM501906*	OM501824*	-	197
Angustitrella vicina 2	lbr 125	Tafaliscinae	Neo	French Guiana, Mitaraka	OM501710**	-	OM501956**	OM501872**	-	-
Apterotrypa mitarakensis	LDG 548	Tafaliscinae	Neo	French Guiana, Mitaraka	OM501698**	-	-	OM501862**	OM501996**	189
Apterotrypa n.sp.1 Foz	DNA 22	Tafaliscinae	Neo	Brazil, Foz do Iguaçu	OM501649*	OM501745*	OM501897*	OM501815*	-	196
Apterotrypa n.sp.2 Jau	DNA 13	Tafaliscinae	Neo	Brazil, Jau	OM501642*	OM501738*	OM501890*	OM501808*	OM501966*	196
Apterotrypa n.sp.3 Cariacica	DNA 43	Tafaliscinae	Neo	Brazil, Cariacica	OM501666*	OM501762*	OM501912*	OM501831*	-	196
Apterotrypa n.sp.4 GUY	LDG 224	Tafaliscinae	Neo	French Guiana, Nouragues	KR903997	KR903806	KR904180	KR903646	KR903124	139
Brazitrypa longiapex	DNA 18	Tafaliscinae	Neo	Brazil, Santa Teresa	OM501645*	OM501741*	OM501893*	OM501811*	OM501969*	197
Brazitrypa n.sp. Foz	DNA 31	Tafaliscinae	Neo	Brazil, Foz do Iguaçu	OM501658*	OM501754*	OM501905*	OM501823*	-	103
Brazitrypa paranaensis	DNA 08	Tafaliscinae	Neo	Brazil, Foz do Iguaçu	OM501640*	OM501736*	OM501888*	OM501806*	-	197
Brazitrypa paulista	DNA 10	Tafaliscinae	Neo	Brazil, Salesópolis	OM501641*	OM501737*	OM501889*	OM501807*	OM501965*	197
Brazitrypa sp. BRA	LDG 296	Tafaliscinae	Neo	Brazil, Santa Lucia	OM501691**	-	OM501937**	OM501855**	-	171
Cylindrogryllus pitanga	DNA 64	Tafaliscinae	Neo	Brazil, Ilhéus	OM501681*	OM501777*	OM501927*	OM501846*	-	197
Neometrypus badius	DNA 42	Tafaliscinae	Neo	Brazil, Cariacica	OM501665*	OM501761*	OM501911*	OM501830*	-	197
Neometrypus catiae	DNA 05	Tafaliscinae	Neo	Brazil, Salesópolis	OM501637*	OM501733*	OM501885*	OM501803*	-	197
Neometrypus couriae	DNA 59	Tafaliscinae	Neo	Brazil, Belterra	OM501677*	OM501773*	OM501923*	OM501842*	-	196
Neometrypus marcelae	DNA 06	Tafaliscinae	Neo	Brazil, Itatiaia	OM501638*	OM501734*	OM501886*	OM501804*	OM501963*	197
Neometrypus azevedoi	DNA 39	Tafaliscinae	Neo	Brazil, Itatiaia	OM501662*	OM501758*	OM501908*	OM501827*	-	197
Neometrypus maiae	LDG 285	Tafaliscinae	Neo	Brazil, Linhares	OM501690**	-	OM501936**	OM501854**	-	174
Perutrella septentrionalis	lbr 407	Tafaliscinae	Neo	French Guiana	OM501713**	OM501798**	OM501959**	OM501876**	OM502009**	197
Tafalisca aff. elongata	DNA 63	Tafaliscinae	Neo	Brazil, Belterra	OM501680*	OM501776*	OM501926*	OM501845*	-	180

Table 1. Continued. Sampled taxa for molecular data. Accession numbers are indicated for GenBank sequences. Realms: Afr-Afrotropic, Aus-Australasia, Ind-Indo-Malay, Neo-Neotropical, Oce-Oceania, Pal-Paleotropical *sequences obtained at *Laboratório de Evolução Molecular* (LEM/USP); ** sequences obtained at *Service de Systématique Moléculaire* (SSM/MNHN); - missing data.

Taxon	Molecular code	Subfamily	Realm	Locality	12S	16S	18S	28SA	28SD	Morphology Characters
Tafalisca ansoi	LDG 109	Tafaliscinae	Neo	French Guiana, Papaichton	KR903913	-	KR904102	-	-	180
Tafalisca bahiensis	DNA 20	Tafaliscinae	Neo	Brazil, Itamaraju	OM501647*	OM501743*	OM501895*	OM501813*	OM501970*	103
Tafalisca duckeana	DNA 19	Tafaliscinae	Neo	Brazil, Manaus	OM501646*	OM501742*	OM501894*	OM501812*	-	197
Tafalisca elongata elongata	LDG 499	Tafaliscinae	Neo	French Guiana, Mitaraka	OM501695**	OM501787**	OM501942**	OM501860**	OM501994**	197
Tafalisca hugeli	LDG 553	Tafaliscinae	Neo	French Guiana, Mitaraka	OM501699**	OM501790**	OM501945**	OM501863**	OM501997**	180
Tafalisca n.sp.2 GDP1	lbr 083	Tafaliscinae	Neo	Guadeloupe	OM501709**	OM501795**	OM501955**	OM501874**	OM502006**	197
Tafalisca n.sp.2 GDP2	lbr 296	Tafaliscinae	Neo	Guadeloupe	OM501711**	OM501796**	OM501957**	OM501875**	OM502007**	-
Tafalisca sp. Jau	DNA 21	Tafaliscinae	Neo	Brazil, Jau	OM501648*	OM501744*	OM501896*	OM501814*	-	103
Tafalisca vestigialis	DNA 62	Tafaliscinae	Neo	Brazil, Belterra	OM501679*	OM501775*	OM501925*	OM501844*	-	197
Veredatrypa rosai	DNA 29	Tafaliscinae	Neo	Brazil, Veredas	OM501656*	OM501752*	OM501903*	OM501821*	OM501973*	197
Veredatrypa seca	DNA 41	Tafaliscinae	Neo	Brazil, Ubajara	OM501664*	OM501760*	OM501910*	OM501829*	OM501977*	180
				Total of characters	**513**	**473**	**671**	**414**	**495**	**197**

Molecular Data

We documented molecular markers frequently used in molecular studies of Grylloidea (Robillard and Desutter-Grandcolas, 2006; Nattier *et al.*, 2011, 2012; Song *et al.*, 2015; Chintauan-Marquier *et al.*, 2016). These include two mitochondrial markers, rDNA 12s, and rDNA 16s; and two nuclear markers, rDNA 18s, and two sub-unities of rDNA 28s (A and D) (Table 2). In total, we obtained 2,763 base pairs for each specimen when all four markers were sequenced. In this study, we greatly expanded the taxonomic sampling and molecular data for crickets, with 354 new sequences (66.17%), in addition to 114 previously published sequences (21.3%) (Robillard and Desutter-Grandcolas, 2006; Chintauan-Marquier *et al.*, 2016) (Table 1). In addition, our molecular dataset provides 87.47% of completeness.

DNA was extracted from the mid (large specimens) or hind (small specimens) femora muscular tissue of dried or alcohol preserved material. The specimens were selected based on conservation and age. Newly collected specimens had the mid or forelegs dissected and stored in ethanol P.A. under -20°C. All procedures for DNA sequencing were conducted in the Laboratório de Evolução Molecular (LEM) of Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo (USP) (Brazil), and in the Service de Systématique Moléculaire (SSM) of Muséum national d'Histoire naturelle (MNHN) (France) (Table 1).

In LEM, ammonium acetate protocol was used for DNA extraction. The PCR products were purified using Agencourt Ampure XP kit (Beckman Coulter) and prepared for sequencing with BigDye® Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems). Samples were sequenced at Departamento de Botânica, IB-USP. In SSM, DNA extraction was automatized with the workstation epMotion® 5075 following the operating manual. QIAamp DNA tissue micro kit (QIAGEN) was used following the manufacturer's instructions. The PCR products were sent to Eurofins in France for sequencing. All sequences were analyzed for quality, assembled in the software package Phred/Phrap (Ewing and Green, 1998; Ewing *et al.*, 1998), edited in Consed (Gordon and Green, 2013), and visualized in AliView (Larsson, 2014).

Table 2. Molecular markers used in this study.

Gene	Primer		Base pairs	Reference
12S rRNA	12SF	TACTATGTTACGACTTAT	~500	Kambhampati (1995)
	12SR	AAACTAGGATTAGATACCC		
16S rRNA	16S AG	CGCCTGTTTATCAAAAACATGT	~470	Robillard and Desutter-Grandcolas (2006)
	16S AG	AGATCACGTAAGAATTTAATGGTC		
18S rRNA	18s A2	ATGGTTGCAAAGCTGAAAC	~670	Giribet *et al.* (1999)
	18S 9R	GATCCTTCCGCAGGTTCACCTAC		
28SA rRNA	28S R1.2a	CCCSSGTAATTTAAGCATATTA	~400	Whiting (2002)
	28S Rd3b	CCYTGAACGGTTTCACGTACT		Jarvis *et al.* (2004)
28SD rRNA	28S F4	CGACACGCCCCGATCCTCAGAGCCA	~500	Chintauan-Marquier *et al.* (2016)
	28S R4	GATTCTGACGTGCAAATCGATC		

Morphological data

The morphological matrix is based on characters of adult males and females, including male genitalia. The specimens were examined under stereomicroscope Zeiss Stemi DV4 and Wild M3Z. The morphological terminology adopted, including the male phallic complex, follows Desutter (1987), Desutter-Grandcolas (2003), and Campos and Desutter-Grandcolas (2020). The nomenclature of forewings venation follows Desutter-Grandcolas *et al.* (2017), modified by Schubnel *et al.* (2019), based on Bethoux and Nel, (2001) for fossils. Male phallic complex was dissected and cleared in KOH 10% for a few hours (depending on the degree of sclerotization of each specimen) and stored individually with the specimen. Drawings were made under a Leica MZ9.5 and a Wild M3Z stereomicroscope coupled with camera lucida. Photographs were taken with a Leica DFC-420 camera coupled to a Leica MZ16 stereomicroscope and with a Canon 60D with macro lens 100 mm and 65 mm 1-5x coupled using the software Helicon Remote. Photographs were edited with Affinity Photo. Plates and drawings were produced in Affinity Designer.

Some characters of forewings were investigated using scanning electron microscopy (SEM). Samples of male forewings were dehydrated in a graded ethanol series until 100%, critical point dried using CO_2 as intermediate fluid, mounted on stubs, and coated with gold. Samples were examined using a Scanning Electron Microscope Zeiss SIGMA VP at the Instituto de Biociências da Universidade de São Paulo (Biosciences Institute of the University of São Paulo).

Character description follows Sereno (2007), and the matrix was constructed in Mesquite 3.61 (Maddison and Maddison, 2021). Inapplicable characters were coded as “-” and unobserved characters as “?”. Out of 197 characters (170 binary and 27 multistate), seven are based on previous studies (Robillard and Desutter-Grandcolas, 2004; Souza-Dias, 2015), and 190 are proposed for the first time in this study. WinClada (Nixon, 2002) was used to map and identify morphological synapomorphies and homoplasies over the resulting trees. The list of characters and illustrations (Figs S1-S9) are provided in Appendix 1, and the morphological matrix in Appendix 2. Morphological characters mapped over trees with fast optimization are indicated in the supporting information (Fig. S10).

Abbreviations

The abbreviations used to describe characters, indications on figures, diagnosis, and to cite along the text are listed below:

Forewings

FW: forewing
HW: hindwing
Sc: subcostal
PCu: post-cubital (stridulatory file)
hv: harp veins
CuP: cubital posterior
CuPa: anterior branch of CuP
CuPb: posterior branch of CuP
R: radial
M+CuA: medial + cubital anterior

Thorax

DD: dorsal disc

Ovipositor

dv: dorsal valves of ovipositor

vv: ventral valves of ovipositor

Legs

T: tibia

F: femur

I, **II**, **III**: anterior, medial, posterior (legs, tibia, and femur)

iad, **iam**, **iav**: inner apical dorsal, median, ventral (spurs)

oad, **oam**, **oav**: outer apical dorsal, median, ventral (spurs)

tar: tarsomere

TIII subapical and apical spurs formula indicated inner/outer respectively, counted from distal spurs upward.

Male genitalia

LLophi: lateral lophi of pseudepiphallus

MedLophi: median lophi of pseudepiphallus

PsP: pseudepiphallic paramere

PsAp: pseudepiphallic apodeme

r: rami

arc: ectophallic arc

EctF: ectophallic fold

vpEct: ventral projection of ectophallic invagination

EctAp: ectophallic apodeme

End: endophallus

EndAp: endophallic apodeme

Phylogenetic Analyses and Divergence Time Estimation

Multiple alignments were generated through MAFFT 7.310 (Katoh *et al.*, 2002; Katoh and Standley, 2014) under the following parameters: globalpair, maxiterate 16, reorder. Since not all regions of a gene evolve at the same rate, it is frequent that some regions of the alignment are highly conserved (without information) and/or others extremely divergent and full of gaps. Thus, it is recommended to remove these conflicting phylogenetic information regions (Lake, 1991; Olsen and Woese, 1993; Swofford *et al.*, 1996; Lutzoni *et al.*, 2000). Consequently, Gblocks (Castresana, 2000) was applied under less stringent parameters through Seaview (Galtier *et al.*, 1996) to identify and remove redundant or highly heterogeneous sites on 28SD fragments.

Sequences were concatenated with SequenceMatrix (Vaidya *et al.*, 2011). Phylogenetic analyses were performed under Maximum likelihood criteria (ML) and Maximum parsimony (MP) with combined molecular and morphological data. Bayesian inference (BI) was conducted to estimate clade divergence times using only molecular data.

Model selection was carried out by ModelFinder (Kalyaanamoorthy *et al.*, 2017) under corrected Akaike Information Criterion (AICc), resulting in GTR+F+R6 for the molecular data concatenated and ORDERED+FQ+ASC+G4 for the morphological matrix. ML analysis was performed by IQTREE 1.6.1 (Nguyen *et al.*, 2015), and branch support was estimated by ultrafast bootstrap (UB) (Hoang *et al.*, 2018), with 5,000 replicates, and bootstrap (B) (Felsenstein, 1985), with 500 replicates.

MP analysis was conducted under TNT 1.5 (Goloboff and Catalano, 2016) with 100 replicates holding 10,000 trees per replicate, ratchet 200, drift 200, and fuse 10. The branch support was estimated by bootstrap (Felsenstein, 1985) and Jackknife (JK) (Farris *et al.*, 1996) with 1,000 replicates each. Consistency index (ci) (Kluge and Farris, 1969) and retention index (ri) (Farris, 1989) were calculated.

BI was used to estimate clade divergence times under the Fossilized Birth-Death model (Heath *et al.*, 2014) in BEAST2 (Bouckaert *et al.*, 2019). A relaxed molecular clock was applied, assuming an uncorrelated log-normal model on branch rates (Drummond *et al.*, 2006; Gavryushkina *et al.*, 2014). Posterior probabilities (pp) were sampled using Markov chain Monte Carlo (MCMC) method for three independent chains with 100,000,000 generations, pre-burnin for 25,000,000 generations, and sampling every 5,000 generations. Convergence of posterior probabilities was visually analyzed in Tracer 1.7.1 (Rambaut *et al.*, 2018) and verified in the R package Convenience 1.0 (Fabreti and Höhna, 2021) based on effective sample size (ESS > 625) for all continuous parameters and split frequencies (supporting information, File S1).

Tree files were assembled in LogCombiner (Bouckaert *et al.*, 2019). Then, trees were summarized as a maximum clade credibility tree after pruning fossil taxa and removing a burn-in of 10% in TreeAnnotator (Bouckaert *et al.*, 2019). Posterior probabilities on the nodes and bars indicating 95% highest posterior density intervals (HPD) were annotated with R package Strap 1.4 (Wills, 1999) and posteriorly edited in Affinity Designer. A plot of lineages-through-time was generated in IcyTree (Vaughan, 2017). In order to facilitate figure presentation, HPD bars were indicated only on nodes of interest. The time-calibrated tree with HPD bars for all nodes is available in the supporting information (Fig. S11).

Fossil ages were obtained from Paleobiology Database (paleobiodb.org) and confirmed with original descriptions of each fossil. The root age of the tree was assumed from the gap of the two most ancient fossils of extinct families of Grylloidea between 182.7 and 208.5 Myr: *Sinagryllus xinjiangens*is (Baissogryllidae) (Wang *et al.*, 2019) and *Protogryllus* (*Protogryllus*) *grandis* (Protogryllidae) (Zeuner, 1937). Another six fossils were selected to calibrate internal node ages, two used in a previous study (Vicente *et al.*, 2017), *Araneagryllus dylani* (Phalangopsidae, Luzarinae) 17.1 ± 7 Myr (Heads, 2010) and *Proanaxipha madgesuttonae* (Gryllidae, Pentacentrinae) 17.1 ± 7 Myr (Heads *et al.*, 2012). Besides these, we also included *Araripegryllus camposae* (Gryllidae n. def.) 117 ± 7 Myr (Martins-Neto, 1991), *Birmaninemobius hirsutus* (Trigonidiidae, Trigonidiinae) 96.55 ± 4 Myr (Xu *et al.*, 2020), *Madasumma europensis* (Oecanthidae n. status) 35.95 ± 3 Myr (Chopard, 1936), and *Stenogryllodes brevipalpis* (Oecanthidae n. status) 35.95 ± 3 Myr (Chopard, 1936).

The classification of orthopteran fossils is historically marked by misidentifications and difficulties related to homology assessment (Desutter-Grandcolas et al., 2021). To ensure a reliable classification of the fossil taxa used to calibrate the age of internal nodes, fossil morphological data were included in the morphological matrix and concatenated with the molecular data matrix. Posteriorly, we conducted a Bayesian Inference in BEAST2 using MCMC method with 50,000,000 generations, pre-burin for 12,500,000 , and trees sampled every 5,000 generations. Based on this approach, the classification of all six fossil taxa was confirmed. The morphological matrix with the fossils (Table S1) and the resulting summarized tree with fossils position (Fig. S12) are provided in appendix 2 and supporting information, respectively.

Results

Morphological matrix

A total of 197 characters were constructed based on external morphology from 95 terminals (Table 1): 27 from the head, 43 from the forewings, 12 from the thorax, 15 from the ovipositor, 47 from the legs, and 48 from the male genitalia. The characters, their states, illustrations (Figs S1-S9), and, when necessary, comments are listed in Appendix 1.

Phylogenetic analyses and divergence time

Our results corroborate the Clade F + G proposed by Chintauan-Marquier et al. (2016). This clade is divided into two main clades, named F and G, with high node support (Figs 2, S13, S14), including those for subfamilies, supertribes, and tribes (posterior probability = 1). Thus, we propose considering clade F as a fifth family of Grylloidea, i.e. family Oecanthidae n. status, recovered as sister-group of Gryllidae n. def. in all analyses. The family Oecanthidae n. status comprises four well-supported clades, corresponding to subfamilies Euscyrtinae Gorochov, 1985; Oecanthinae Blanchard, 1845; Podoscirtinae Saussure, 1878; and Tafaliscinae Desutter, 1988. Euscyrtinae is the sister group of the other three subfamilies, with the following topology: Euscyrtinae + ((Oecanthinae + Podoscirtinae) + Tafaliscinae) (Figs 2, S13, S14, Table 3).

Each subfamilial clade includes subsequent divisions, which we consider as supertribes and tribes (Fig. 2). Two supertribes divide Oecanthinae: Oecanthidi n. status, with Oecanthini Blanchard, 1845 and Xabeini Vickery & Kevan, 1983 tribes; and Diatrypidi Desutter, 1988 n. status, with only one tribe, Diatrypini Desutter, 1988. Podoscirtinae is composed by Podoscirtidi Saussure, 1878 n. status and Hapithidi Gorochov, 1985 n. status. Podoscirtidi n. status with Aphonoidini Gorochov, 2008, Podoscirtini Saussure, 1878, and Truljaliini Gorochov, 2020 n. status; their relationship is the same in all analyses: Truljaliini + (Aphonoidini + Podoscirtini). Hapithidi n. status has four tribes, one of which is new: Aphonomorphini Desutter, 1988; Cearacesaini Koçak & Kemal, 2010; Hapithini Gorochov, 1986; and Phyllogryllini Campos, n. tribe; with the relationship Cearacesaini + (Hapithini + (Aphonomorphini + Phyllogryllini)). Tafaliscinae is reerected with two supertribes: Paroecanthidi n. status divided into

Paroecanthini Gorochov, 1986 and Neometrypini Desutter, 1988; and Tafaliscidi Desutter 1988 n. status with a single tribe, Tafaliscini Desutter, 1988.

The topology for divergence times under BI (Fig. 2) is similar to the topologies obtained under ML (Fig. S13) and MP (Fig. S14), including all main clades mentioned above, such as subfamilies, supertribes, and tribes. Only minor differences were observed on internal nodes of Diatrypidi n. status, Oecanthidi n. status, and Tafaliscidi n. status (Fig. 2). Inside Podoscirtidi clade, *Prozvenella bangaloriensis* belongs to Podoscirtini, while it has a sistership relation to all taxa of Podoscirtidi except Truljaliini in ML and MP. Finally, in the Neometrypini clade, *Cylindrogryllus pitanga* is the sister group of *Brazitrypa* + *Neometrypus*, while it is the sister group of *Neometrypus* only in ML and MP. The majority of nodes have pp = 1 (Fig. 2). Results of ML and MP trees are in supporting information (File S2, Figs S13, S14).

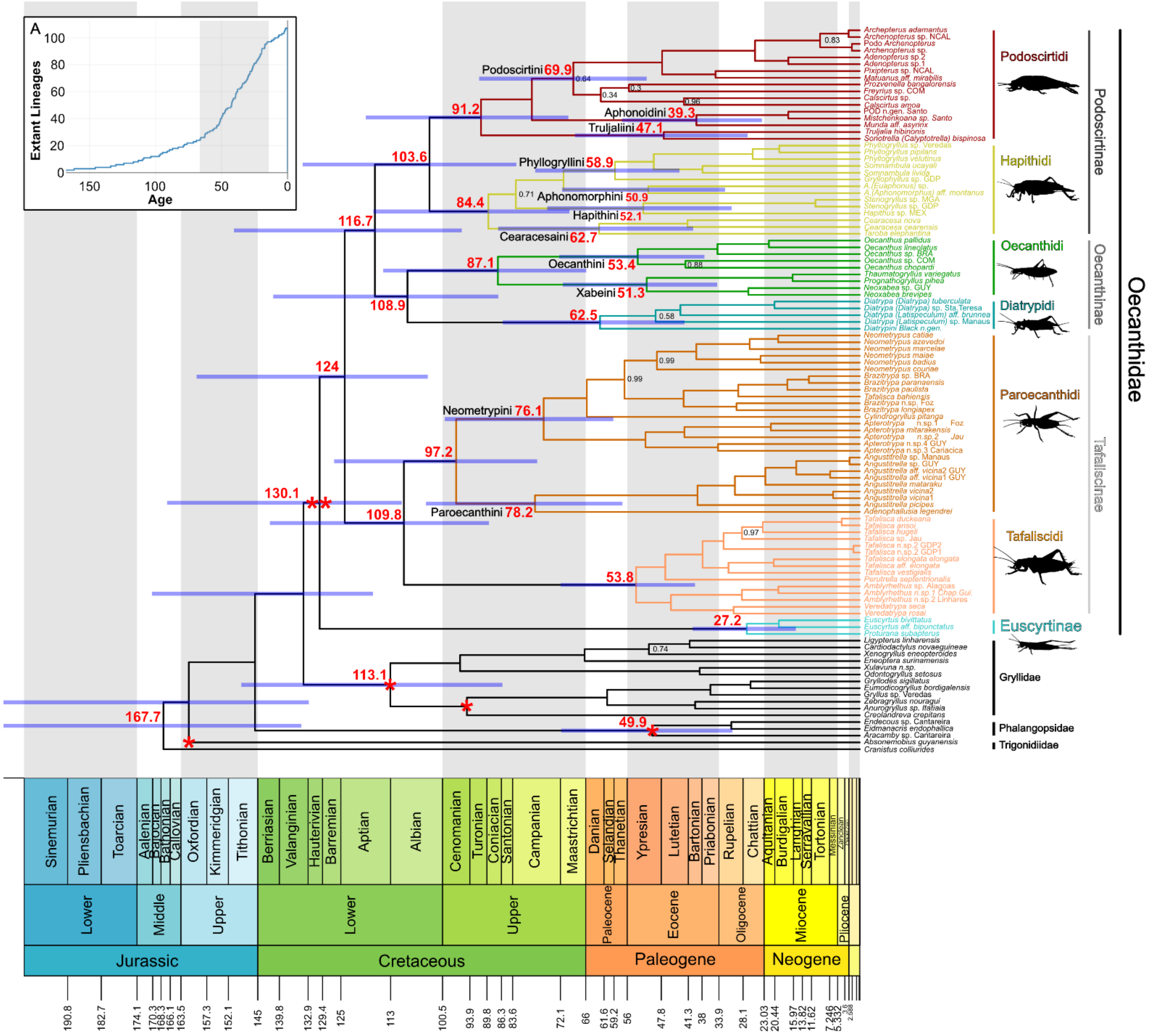


Figure 2. Time-calibrated phylogenetic tree of Oecanthidae n. status. Divergence time analysis under Bayesian inference based on four DNA markers and six fossil calibrating internal nodes (red asterisks). Red numbers are the mean ages of the nodes. Bars indicate 95% highest posterior density intervals for nodes of interest. Posterior probabilities different than 1 are indicated in black numbers on nodes. A- Lineages-through-time plot.

Table 3. Classification of Oecanthidae n. status based on the ML, MP, and BI resulting trees.

Oecanthidae **n. status**	Euscyrtinae		
	Oecanthinae **n. def.**	Oeacanthidi **n. status**	Oecanthini Xabeini
		Diatrypidi **n. status**	Diatrypini
	Podoscirtinae **n. def.**	Podoscirtidi **n. status**	Aphonoidini Podoscirtini Truljaliini **n. status**
		Hapithidi **n. status**	Hapithini Aphonomorphini Cearacesaini Phyllogryllini **n. tribe**
	Tafaliscinae **n. def., n. status**	Tafaliscidi **n. status**	Tafaliscini
		Paroecanthidi **n. status**	Paroecanthini Neometrypini

According to OSF (Cigliano *et al.*, 2022) and our generic list records (Appendix 3), Euscyrtinae are distributed in the Afrotropics, Australasia, and Indo-Malayan, with some representatives in Central America (Neotropical Region). Podoscirtinae and Oecanthinae are distributed worldwide. Podoscirtidi (Podoscirtinae) are distributed through Afrotropic, Australasia, Indo-Malyan, Oceania, and Palearctic. Tafaliscinae and Diatrypidi (Oecanthinae) are exclusively from Neotropical Region. Oecanthidi (Oecanthinae) are distributed worldwide. Hapithidi (Podoscirtinae) are in the Neotropics and in the south of the Nearctic Region. Cearacesaini (Podoscirtinae, Hapithidi) and Neometrypini (Tafaliscinae, Paroecanthidi) are restricted to South America (Fig. 3).

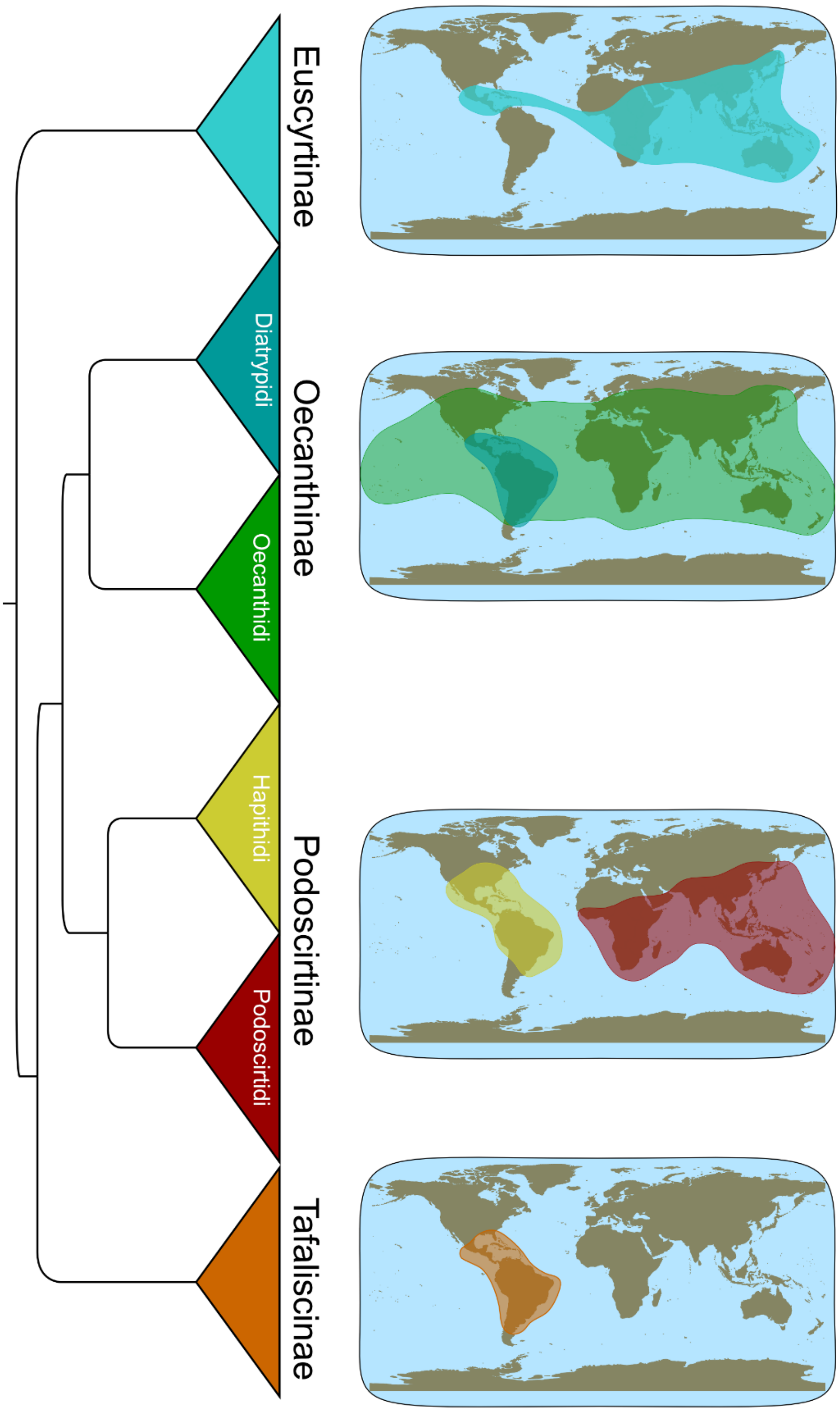


Figure 3. Distribution maps of Oecanthidae n. status subfamilies and supertribes.

Divergence Times

The divergence times were estimated for supra generic clades with 95% highest posterior density interval (HPD): Oecanthidae n. status, 130.1 Myr (109.9-166.8 Myr); Euscyrtinae, 27.2 Myr (15.4-40.2 Myr); Oecanthinae, 109.6 Myr (87.3-141.77 Myr); Podoscirtinae, 103.7 Myr (82.5-134.3 Myr); Tafaliscinae, 109.8 Myr (88.9-142 Myr). The split between Tafaliscinae n. def. n. status and Oecanthinae n. def. + Podoscirtinae n. def. likely occurred around 124 Myr, and the split of Podoscirtidi n. status and Hapithidi n. status is estimated around 103.6 Myr, both in the Lower Cretaceous. The most recent common ancestors of many supertribes date back to the Upper Cretaceous, including Oecanthidi n. status (87.2 Myr), Podoscirtidi n. status (91.2 Myr), Hapithidi n. status (89.4 Myr), and Paroecanthidi n. status (97.2 Myr). Diatrypidi n. status (62.6 Myr) and Tafaliscidi n. status (53.9 Myr) diverged during the Paleocene.

While some tribes have ancient origins during the Upper Cretaceous, like Podoscirtini (68.9 Myr), Paroecanthini (78.2 Myr), Neometrypini (76.1 Myr); more recent divergences include Cearacesaini (62.7 Myr) in the Eocene; Xabeini (51.3 Myr), also Oecanthini (53.4 Myr), Truljaliini n. status (47.3 Myr), Aphonoidini (39.2 Myr), Hapithini (52.1 Myr), Aphonomorphini (50.9 Myr), and Phyllogryllini n. tribe (49.6 Myr) during the Paleocene. The mean ages are indicated on suprageneric nodes in figure 2. The Lineage Through Time plot (Fig. 2A) indicates a sharp increase of lineages around 60 Myr and 20 Myr, during the Paleogene.

Classification

Based on our results, we are proposing a new classification to organize hierarchically Oecanthidae n. status (Table 3). Morphological synapomorphies of the family, subfamilies, and supertribes are listed in Table 4, those of tribes in Table 5, and the characters mapped onto the trees in the supporting information (Fig. S10). Diagnosis of each taxonomic category of Oecanthidae n. status with included genera is provided in Appendix 3 (Figs. S15-S29). Moreover, an identification key of all suprageneric ranges complimented with tafaliscine genera is presented in Appendix 4 (Fig. S30).

As a consequence of our study, Chintauan-Marquier *et al.* (2016) 's clade G should be restricted to Gryllinae, Gryllomiminae, Eneopterinae, Itarinae, Landrevinae, Pentacentrinae, Sclerogryllinae and the Odontogryllini; Gryllomorphinae gathered within the phalangopsid subfamily Cachoplistinae in Chiantaun-Marquier et al. (2016)'s phylogeny. As for clade F; the limits, diagnoses and relationships of these taxa should be revised through phylogenetic studies.

Table 4. Morphological synapomorphies of Oecanthidae n. status and its subfamilies and supertribes.

Family	Subfamily	Supertribe	State of character	
Oecanthidae			Ovipositor straight in lateral view	102(0)
			iad spur three times or more longer than oad spur of TIII	133(1)
			Tarsomere I and II of legs I and II same-sized	138(0)
	Euscyrtinae		Fastigium top truncated in frontal view	15(0)
	Oecanthinae		Apex of dorsal valves of ovipositor bifurcate	91(3)
			iav spur of TIII very reduced	136(1)
			Endophallic sclerite two times longer than pseudepiphallic sclerite	194(2)
		Diatrypidi	Apex of ventral valves of ovipositor bifurcate	100(3)
			Dorsal valves of male genitalia present and well developed	197(1)
		Oecanthidi	Mouthparts prognathous	24(0)
			Inner ventral spur of TI absent	111(0)
			Inner ventral spur of TII absent	115(0)
			Dorsal spines of tarsomere I on inner margin of leg III absent	140(0)
			Dorsal spines of tarsomere I on outer margin of leg III absent	141(0)
			Claws bifid	149(1)
			Ectophallic arc curved anteriorly	178(2)
	Podoscirtinae		Ventral serrulation on apex of ovipositor dorsal valves present	93(1)
			Ectophallic fold apex bilobate	181(1)
			Endophallus posterior projection double	196(1)
		Hapithidi	Median and lateral ocelli aligned	9(1)
			Harp veins parallel to stridulatory file (PCu)	47(1)
			Bilobate apex of ectophallic fold connected	182(1)

Table 4. Continued. Morphological synapomorphies of Oecanthidae n. status and its subfamilies and supertribes.

Family	Subfamily	Supertribe	State of character	
		Podoscirtidi	Stridulatory file (PCu) curved forming a 90° angle	41(0)
			Proximal region of the stridulatory file (PCu) parallel to CuPa	42(0)
			Pseudepiphallic sclerite MedLophi very short	158(1)
			Pseudepiphallic MedLophi dorsal to LLophi	159(2)
	Tafaliscinae		Stridulatory file sinuosity close to CuPa	40(1)
			Ovipositor dorso-ventrally flattened	88(1)
			PsAp posteriorly directed	169(1)
		Tafaliscidi	Apex of dorsal valves of ovipositor truncated	91(1)
			Apex of ventral valves of ovipositor truncated	100(2)
		Paroecanthidi	Endophallic sclerite dorso-ventrally flattened	190(1)

Table 5. Morphological synapomorphies of tribes of Oecanthidae n. status.

Supertribe	Tribe	State of character	
Oecanthidi	Xabeini	Cerci shorter than FII	83(0)
		Subapical spurs of TIII absent	120(0)
		oav spur absent	135(0)
		Inner apical spur of tarsomere I of leg III absent	144(0)
		Outer apical spur of tarsomere I of leg III absent	146(0)
	Oecanthini	Outer ventral spur of TII absent	116(0)
		Distal projection of ectophallic arc present	179(1)
Hapithidi	Cearacesaini	-	
	Hapithini	PsP lateral	165(1)
		PsP connected to pseudepiphallic sclerite	166(1)
	Aphonomorphini	Ectophallic arc straight	178(0)
	Phyllogryllini	-	
Podoscirtidi	Truljaliini	Pronotum DD flatenned in lateral view	74(1)
	Aphonoidini	-	
	Podoscirtini	Pseudepiphallic sclerite capsular	151(1)
Paroecanthidi	Paroecanthini	Stridulatory file (PCu) bisinuos	39(2)
		Harp veins divided into two clusters	48(1)
		TI inflated	103
		PsP strongly reduced	162(1)
		Ectophallic invagination strongly reduced	174(1)
	Neometrypini	-	

Discussion

We provide the first well-supported phylogeny of a family of true crickets (Grylloidea), including a time-calibrated tree, based on molecular and morphological data for a broad taxon sampling. The Oecanthidae n. status, distributed worldwide, is the second most speciose family of Grylloidea with ~1,400 species, just behind the Gryllidae s. str., its sister family (Cigliano *et al.*, 2022). This clade is divided into four monophyletic subfamilies, i.e., Euscyrtinae, Oecanthinae n. def., Podoscirtinae n. def., and Tafaliscinae n. def. n. status (Table 3, Figs 2, S13, S14). To provide a phylogenetically-informed classification, we organize all subfamilies based on monophyletic supertribes and tribes (Figs 2, S13, S14). These clades are delimited by morphological characters, synapomorphic and/or homoplastic (Tables 4 and 5; Appendix 3-Diagnoses). Our phylogenetic results also support the definition of a new well-supported tribe, the Phyllogryllini Campos, n. tribe (Podoscirtinae: Hapithidi). All analyses (BI, ML, MP) support the same relationships across subfamilies, supertribes, and tribes, even with a few species switching their phylogenetic positions.

Molecular data is provided for the first time for the Xabeini tribe (Oecanthinae: Oecanthidi), and the genus *Diatrypa*, which composes Diatrypidi n. status. The terminal named "*Diatrypa* sp_FGu" (voucher LDG 092, reexamined) in clade F3 of Chintauan-Marquier *et al.*, (2016) actually belongs to the genus *Angustitrella* (Paroecanthidi: Tafaliscinae). Therefore, the species is included herein as "*Angustitrella aff. vicina* 1" (Table 1).

Oecanthidae n. status phylogenetic relationships

Oecanthidae n. status was previously designated as Clade F (Chintauan-Marquier et al. 2016) or part of the 'Subfamily Group Podoscirtinae' (SGP) (Gorochov, 2015; Cigliano *et al.*, 2022). The SGP included Euscyrtinae, Hapithinae (here Hapithidi), Pentacentrinae, and Podoscirtinae (here Podoscirtidi), the latter including a number of tribes and subtribes, which we reorganize here based on our phylogenetic results (Cigliano *et al.*, 2022). Chintauan-Marquier et al. (2016) recognized five clades in Clade F, which included taxa belonging to Euscyrtinae, Oecanthinae, Podoscirtinae, Hapithinae, and Tafaliscinae, while Pentracentrinae belonged to Clade G, together with Landrevinae, Eneopterinae, and Gryllinae; no taxonomic conclusions were proposed by those authors, who highlighted the need of additional taxon sampling. Clades F and G were provisionally gathered in the expanded 'Gryllidae' family; consequently, the prior definition of 'Gryllidae' is a mix of 'subfamily groups' and subfamilies, without recognizing monophyletic groups (Cigliano *et al.*, 2022). Here, we provide evidence to (1) separate two monophyletic cricket families, i.e., Gryllidae n. def. and Oecanthidae n. status, and (2) subdivide the Oecanthidae n. status into four subfamilies, i.e., Euscyrtinae + ((Oecanthinae n. def. + Podoscirtinae n. def.) + Tafaliscinae n. def. n. status). Consequently, our results clarify the phylogenetic relationships across this diverse clade and stabilize its taxonomy.

Initially separated as '*Euscyrtus* species group' within a Podoscirtini tribe (*sensu* Otte and Alexander, 1983), Euscyrtinae has been considered a valid subfamily since its creation (Gorochov, 1985). Its monophyly was confirmed based on molecular data (Chintaun-Marquier et al. 2016), and our morphological data support previous results (see Table 1). In our analyses, Euscyrtinae is the sister-group of the other subfamilies of Oecanthidae n. status. Euscyrtinae is the less diverse lineage of Oecanthidae n. status with ~60 species (Cigliano *et al.*, 2022), which live in herbaceous environments, including disturbed places. Our results indicate that this subfamily has diversified more recently than the other Oecanthidae n. status. (~23 Myr). According to Cigliano *et al.* (2022), Euscyrtinae are distributed through all tropical regions except South America. However, individuals with Euscyrtinae characteristics from Brazil were found in the MNHN collection (LDC pers. obs.). A paper with this new significant record is in progress (Campos in prep.).

A sister-group relationship between Oecanthinae and Podoscirtinae was firstly proposed by Otte (1994). However, Oecanthinae was limited to the genus *Oecanthus* and its closest relatives. Probably isolated because of its specialized morphology. For example, in Chopard's 1967 - 1968 catalog, this was the only group set apart of all crickets as a 'family' (but see Chopard's 1968 introduction to the Catalogue to understand this choice). As shown in Figure 2, Oecanthinae n. def. is the sister group of Podoscirtinae n. def. and includes the supertribes Diatrypidi n. status (Neotropical) and Oecanthidi n. status (worldwide).

The supertribe Diatrypidi n. status was initially proposed as a tribe of Tafaliscinae with two genera, i.e., *Diatrypa* and *Prodiatrypa* (Desutter, 1988): *Diatrypa* was transferred into a subtribe (Diatrypina) of the tribe Aphonoidini in the Podoscirtinae subfamily (Gorochov, 2013), while *Prodiatrypa* was included in the subtribe Tafaliscina

(Gorochov, 2017). Based on morphological characters (see Appendix 3), *Prodiatrypa* is here transferred to the Paroecanthini tribe of the Tafaliscinae n. def., n. status.

With worldwide distribution (Cigliano *et al.*, 2022), Oecanthidi have two tribes, Oecanthini and Xabeini. Only three genera compose Oecanthini (Appendix 3), of which *Oecanthus*, with more than 70 species, is a relatively well-studied genus, used as a model group for behavioral studies (e.g., Costello and Symes, 2014; Orci *et al.*, 2016), bioacoustics (e.g., Sismondo, 1993; Walker and Collins, 2010; Collins *et al.*, 2019), biophysics (e.g., Mhatre *et al.*, 2009, 2017), and cytogenetics (Milach *et al.*, 2016). Xabeini is characterized by the lack of subapical spurs of posterior tibia; it includes one genus in the Neotropics, one genus in Asia - Oceania, and a remarkable eco-morphological diversity in the Hawaiian archipelago, with three genera and 68 species (Otte, 1994, Cigliano et al. 2022).

Podoscirtinae n. def. is the most diverse subfamily of Oecanthidae n. status, with more than 80 genera and 650 species (Cigliano *et al.*, 2022). Although worldwide in distribution, it is divided here into the southern Nearctic and Neotropical Hapithidi n. status on the one hand, and Afrotropical, Australasia, Indo-Malayan, Oceanian, and Palearctic Podoscirtidi n. status on the other. This geographical separation was not evident in previous classifications. It was first observed by Chintauan-Marquier et al. (2016), who recovered the subfamily with 19 terminals and is corroborated by our broad taxon sampling (Table 1).

According to our results, Hapithidi n. status have four tribes, including Phyllogryllini n. tribe, sister of Aphonomorphini (Figs. 2, S13, S14, Appendix 3). Podoscirtidi n. status is composed of three tribes, of which Truljaliini n. status is elevated from subtribe (Gorochov, 2020). *Prozvenella bangaloriensis* appears as a sister group of Aphonoidini + Podoscirtini in the ML and MP trees, but is nested within Podoscirtini in the BI tree. We decided to maintain this species in Podoscirtini for now, following our results of BI. Further studies focused on Podoscirtidi are required to elucidate the phylogenetic relationships of this taxon, as our sampling of Podoscirtidi is low compared to the group diversity.

The subfamily Tafaliscinae n. def., n. status is strictly Neotropical, occurring from southern Mexico and southern Florida peninsula to southern Brazil and northern Argentina (Cigliano *et al.*, 2022). Unlike Chintauan-Marquier's *et al.* (2016) tree, which was based on only four tafaliscine terminals, our results show Tafaliscinae as the sister of Oecanthinae n. def. + Podoscirtinae n. def. (Figs. 2, S13, S14). With 42 species sampled, our results reveal, with high node supports, that Tafaliscinae n. def., n. status is a diverse monophyletic lineage divided into two supertribes: Paroecanthidi n. status and Tafaliscidi n. status (Figs 2, S13, S14; Table 3).

Paroecanthini and Neometrypini compose Paroecanthidi n. status. The low support of Paroecanthini in ML and MP trees suggests that the position of *Adenophallusia legendrei* could be different in other circumstances (e.g., different dataset or more taxa of Paroecanthini). Nevertheless, we decided to maintain this species inside Paroecanthini for now. Neometrypini tribe is strongly supported and defined morphologically (Figs. 2, S13, S14; Appendix 3). In this work, we decided to elevate the subgenera of *Cylindrogryllus sensu* Gorochov (2017) to genera based on the obtained topologies and morphological characters. As recently proposed for *Neometrypus* with morphological characters (Campos and Souza-Dias, 2021), *Cylindrogryllus*, *Neometrypus*, and *Apterotrypa* are all taxonomically well-established and morphologically delimited as monophyletic genera now.

The identification of the genera *Brazitrypa* and *Tafalisca* is often confusing (Campos and Desutter-Grandcolas, 2020). According to our results, *Tafalisca bahiensis* (Saussure, 1878) should be transferred to *Brazitrypa*, as supported by molecular and morphological characters: we propose the new combination *Brazitrypa bahiensis* (Saussure, 1878), n. comb. for that species. Interestingly, *Brazitrypa* was never considered close to *Neometrypus*, probably because of its developed forewings (*Neometrypus* is apterous or micropterous). However, other morphological characters, such as the median metanotal projection and genital characters, are very similar in both genera (Campos and Souza-Dias, 2021).

Tafaliscidi n. status includes only one tribe, Tafaliscini n. def. Initially proposed as a tribe of the Tafaliscinae subfamily (Desutter, 1988), this group was later considered a subtribe with several genera that, according to our results, actually belong to Paroecanthidi n. status., i.e., *Adenophallusia*, *Brazitrypa*, *Cylindrogryllus*, and *Prodiatrypa* (Gorochov, 2017; Cigliano *et al.*, 2022). The genus *Eubezverkhovia* Gorochov & Izerskyy, 2020, could not be sampled in the present study, but its morphological features and descriptions (Gorochov, 2017, 2018) are very similar to *Tafalisca* Walker, 1869. Examination of the types of *Eubezverkhovia* is required prior synonymizing both genera. In the same way, the genus *Stenaphonus* Saussure, 1878 will have to be checked for a synonymy with *Tafalisca*. As mentioned in Appendix 3, we transfer this genus from Podoscirtini to Tafaliscidi n.status, according to its morphological features and neotropical distribution.

Oecanthidae n. status divergence times

According to our results, Oecanthidae n. status dates back to the Lower Cretaceous, around 130 Myr, well before another time-calibration hypothesis not explicitly designed for 'Gryllidae' (Vicente *et al.*, 2017, ~58 Myr). The estimated origin of the fifth family of Grylloidea was in a similar period to the early rise of flowering plants in the Lower Cretaceous (145-100 Myr) (Ramírez-Barahona *et al.*, 2020). As oecanthid crickets inhabit plants exclusively (except for a few taxa), our estimation prompts the possibility of an evolutionary association, in which angiosperm diversification might have provided habitats and food (flower parts, fruits, and seeds) for those crickets. The overlap of divergence times also suggests the Oecanthidae n. status as the first group of crickets to use flowering plants as a habitat. The most ancient fossils of other crickets whose extant representatives live on plants belong to Mogoplistidae (Upper Cretaceous, Gorochov, 2010) and Trigonidiinae (Trigonidiidae) (Upper Cretaceous; Xu *et al.*, 2020; Desutter-Grandcolas *et al.*, 2021); the Eneopterinae subfamily (Gryllidae n. def.) is dated from the Paleocene (Vicente *et al.*, 2017), ~66.2 Myr according to our results (Fig. 2).

The lineage-through-time plot (Fig. 2A) shows a sharp increase in the diversity of Oecanthidae n. status starting around 60 Myr, during the Paleocene. This pattern is present in most tribes of the family (Fig. 2). This period is just after the last great extinction of the Cretaceous-Paleogene (~65 Myr) and during the widespread of angiosperms across biomes around the World (66-56 Myr) (Ramírez-Barahona *et al.*, 2020). Accordingly, we raise two non-excluding hypotheses on their evolution: (1) these crickets survived the mass extinction, as also documented for spiders (Penney *et al.*, 2003), with subsequent speciation related to newly available niches; (2) the evolution of Oecanthidae n. status might be related to the expansion of flowering plants based on diversification of resources and habitats.

Only three fossils are unambiguously attributed to Oecanthidae n. status. All belong to the Podoscirtinae subfamily (Cigliano *et al.*, 2022): *Allopterites multilineatus* Cockerell, 1920 (Eocene, incomplete hind wing), *Madasumma europensis* Chopard, 1936 (Oligocene, adult female), and *Stenogryllodes brevipalpis* Chopard, 1936 (Oligocene, anterior part of a male juvenile). The last two were included in our divergence times analysis as stem fossils based on their morphological characters. The discovery of a new, complete fossil of Podoscirtinae n. def. from the mid-Cretaceous, upper Albian (Desutter-Grandcolas et al. submit.), closer to the divergence of Oecanthidae n. status, better supports our results.

Differently from other oecanthids, the Euscyrtinae crickets are known for inhabiting grasses mainly. This subfamily dates back to ~27 Myr, which coincides with the expansion of grasslands in the Late Oligocene and Early Miocene (Edwards *et al.*, 2010), suggesting that Euscyrtinae's diversification is particularly related to grass expansion. Further studies combining phylogenetic data for more Euscyrtinae taxa and speciation/diversification rates are required to test this hypothesis properly. The diversification of the Neotropical Tafaliscinae (~109 Myr) likely occurred before the split between Hapithidi n. status and Podoscirtidi n. status, suggesting that this group started to diversify before the separation of Neotropics and Paleotropics.

The divergence of the sister-groups Hapithidi n. status (~84 Myr) and Podoscirtidi n. status (~91 Myr) likely occurred after the separation of the American and African continents (~100 Myr), indicating a possible vicariant event, as observed in other organisms such as beetles (Toussaint *et al.*, 2017; Short *et al.*, 2021) and lizards (Gamble *et al.*, 2008).

The tribe Xabeini (Oecanthinae) started to diverge about 51.3 Myr. With a particular distribution, this tribe has the genus *Xabea* through Asia and Oceania, the genus *Neoxabea* in the Nearctic and Neotropical regions, and the other three genera (*Leptogryllus*, *Prognathogryllus*, and *Thamatogryllus*) endemic to the Hawaiian Islands. The current distribution of *Xabea* and *Neoxabea* can be explained by the early divergence of Xabeini during the Eocene, when continents were separated, with a southern connection among South America, Antarctica, Australia, and New Guinea (Sanmartíin and Ronquist, 2004). In our analysis, *Prognathogryllus* + *Thaumatogryllus* dates back to ~16 Myr. Their divergence times are older than the oldest massive Hawaiian island among Southeastern Islands, Kauai. Nevertheless, the smaller Hawaiian islands, also known as Northwestern Islands, are older than the emergence of these crickets. Thereby reinforcing the hypothesis that these crickets diversified after arriving at the Hawaiian archipelago from the American continent (Otte, 1994).

Habitat diversity

Oecanthid crickets are largely known for inhabiting different kinds of vegetation and plant stratification (Otte and Alexander, 1983; Ingrisch, 1997; Desutter-Grandcolas *et al.*, 2016; Labadessa and Todisco, 2016; Campos and Desutter-Grandcolas, 2020; Campos *et al.*, 2020). However, there are only a few records about what specific types of vegetation they inhabit. Some Paroecanthini (*Angustitrella* spp.) or Podoscirtini n. def. (*Calscirtus*, *Matuanus*) live in the canopy (LDC pers. obs. for Amazonian taxa; Desutter-Grandcolas *et al.* (2016) for New Caledonia). Species of *Tafalisca* and related genera are often observed running on small branches in low forests (LDG, pers. obs. in French Guiana and Guadeloupe), or staying on leaves in high canopy (Nicolas Moulin, pers. obs. in Guadeloupe). *Brazitrypa* and *Tafalisca* (Tafaliscinae n. def., n. status), *Matuanus* and *Riatina* (Podoscirtinae n. def.) are also found hiding in hollow twigs (Otte and Alexander, 1983; Desutter-Grandcolas *et al.*, 2016; Campos *et al.*, 2020). The species *Veredatrypa rosai* was found in small trees adapted to the Brazilian Cerrado (Campos *et al.*, 2020), while the new caledonian *Pixipterus* lives on small trees in dry maquis vegetation. As already mentioned, Euscyrtinae are recorded from small bushes and grasses (Otte and Alexander, 1983; Desutter-Grandcolas *et al.*, 2016). Finally, the *Prognathogryllus* species group, endemic to the Hawaiian Islands, is the only oecanthid group with representatives not inhabiting only plants, but also found under barks (*Leptogryllus*), in leaf litter, and even in caves (*Thaumatogryllus*) (Otte, 1994), which could support an empty niche hypothesis of diversification.

The contrasting types of vegetation, their range of altitude, and the part of the plants used by the species for their activity or refuge periods are important information that can be used to understand how crickets adapted and evolved through time. Unfortunately, available information about oecanthid habits is still too scarce to propose general hypotheses on habitat evolution. The records mentioned above generally match with the production of airborne sounds. Crickets found in higher habitats, such as *Angustitrella* and *Calscirtus*, have an entire developed stridulatory apparatus, while Neometrypini and Euscyrtinae cannot produce sounds with their forewings and are found in smaller trees, bushes, and grasses. Losing acoustic communication could be associated with particular environments favorable to forewing loss in crickets (Song *et al.*, 2020). Species inhabiting lower habitats could be more susceptible to predators than species in complex canopies of higher trees (Šipoš and Kindlmann, 2013), as they avoid acoustically oriented predators like bats, birds and parasitoids; but they keep facing spiders and frogs, which fiercely predate crickets.

Ovipositor diversity

The ovipositors in Oecanthidae n. status, as already mentioned, are quite diverse and poorly investigated by current cricket taxonomists, although widely used by previous authors (see Saussure, 1878, for example). Our results demonstrated that it is a valuable source of phylogenetically-significant characters. We managed to define 15 characters to describe the ovipositors in Oecanthidae n. status (see Appendix 1 and 3): they contribute defining several clades with exclusive synapomorphies (Tables 4 and 5) and characterize clades almost at all taxonomic levels (Appendix 3). Moreover, ovipositor shapes and apex forms are good indicators for ovipositing sites (Gwynne, 2001). As Oecanthidae n. status are almost exclusively inhabitants of grasses, trees, and bushes, it makes sense that they will generally oviposit inside plant tissues. The serrulated margins of the apex, sometimes with projections, in addition to dorsal and ventral valves movements, contribute to access the internal tissues of the plants that protect the eggs from predators and parasitoids (Huber *et al.*, 1989). Some crickets also bite the plant to make an opening and facilitate oviposition (Gwynne, 2001).

As examples of the diversity of Oecanthidae n. status ovipositors, Euscyrtinae, Tafaliscinae n. def. n. status, and some Oecanthinae (as *Stenoecanthus planixiphus*, Campos & Desutter-Grandcolas 2020) have flattened dorso-ventrally or laterally ovipositors used to oviposit inside leaves. In some Oecanthinae, Aphonoidini (Podoscirtidi: Podoscirtinae) or *Ectotrypa repentina* (Paroecanthini: Tafaliscinae), the apex of the ovipositor is more sclerotized and broader than the rest of the ovipositor, and this seems to be associated with oviposition inside the stem of plants (Huber *et al.*, 1989). The morphological diversity of structures in oecanthid crickets, as ovipositors, are essential clues to understand their habitat preferences and how the use of different habitats has shaped their evolutionary success. More and detailed studies on oviposition, ovipositors characters, and mating behavior could be fundamentals to answer questions about adaptation, morphological evolution, and habitat preferences of these crickets.

Conclusion

Dating back to the Lower Cretaceous (~130 Myr), the Oecanthidae n. status are established as a fifth, monophyletic family of true crickets (Grylloidea) based on molecular and morphological data. Our results support a phylogenetic hypothesis of Oecanthidae n. status, including a time-calibrated phylogeny used to revise and stabilize the classification of the family and its lower taxonomic levels, such as subfamily, supertribes, and tribes. To test the hypotheses on oecanthid evolution proposed here, further sequencing is necessary to improve taxon sampling. In addition, more information of distribution and ecology will greatly contribute to the understanding of processes related to the diversification of this successful group of crickets. In conclusion, this study provides a solid phylogenetic framework for the fifth family of true crickets and demonstrates the high potential of oecanthids as a model group for studies focused on behavior, biogeography, bioacoustics, and trait evolution.

References

Anso, J., Jourdan, H., Desutter-Grandcolas, L. 2016. Crickets (Insecta, Orthoptera, Grylloidea) from Southern New Caledonia, with descriptions of new taxa. Zootaxa. 4124, 1–92. doi:10.11646/zootaxa.4124.1.1

Bailey, W.J. 1991. Acoustic behaviour of insects. An evolutionary perspective.. Chapman and Hall, Cambridge.

Bethoux, O., Nel, A. 2001. Venation pattern of Orthoptera. Journal of Orthoptera Research. 10, 195–198. doi:10.1665/1082-6467(2001)010[0195:VPOO]2.0.CO;2

Bouckaert, R., Vaughan, T.G., Barido-Sottani, J., Duchêne, S., Fourment, M., Gavryushkina, A., Heled, J., Jones, G., Kühnert, D., Maio, N.D., Matschiner, M., Mendes, F.K., Müller, N.F., Ogilvie, H.A., Plessis, L. du, Popinga, A., Rambaut, A., Rasmussen, D., Siveroni, I., Suchard, M.A., Wu, C.-H., Xie, D., Zhang, C., Stadler, T., Drummond, A.J. 2019. BEAST 2.5: An advanced software platform for Bayesian evolutionary analysis. PLOS Computational Biology. 15, e1006650. doi:10.1371/journal.pcbi.1006650

Campos, L.D. de, Desutter-Grandcolas, L. 2020. The Paroecanthini crickets (Orthoptera: Grylloidea: Gryllidae: Oecanthinae) from French Guiana. Zoosystema. 42, 355–398. doi:10.5252/zoosystema2020v42a20

Campos, L.D. de, Souza-Dias, P.G.B. de, Desutter-Grandcolas, L., Nihei, S.S. 2021. Colonization of different biomes drove the diversification of the Neotropical Eidmanacris crickets (Insecta: Orthoptera: Grylloidea: Phalangopsidae). PLOS ONE. 16, e0245325. doi:10.1371/journal.pone.0245325

Campos, L.D. de, Souza-Dias, P.G.B. 2021. Hidden in the bushes: uncovering the diversity of the genus *Neometrypus* Desutter, 1988 n. status (Orthoptera: Gryllidae: Paroecanthini: Tafaliscina) in Neotropical forests. Zootaxa. 5060, 451–488. doi:10.11646/zootaxa.5060.4.1

Campos, L.D. de, Souza-Dias, P.G.B., Nihei, S.S. 2020. New Brazilian Tafaliscina increase the diversity of this Neotropical cricket clade (Orthoptera: Grylloidea: Gryllidae: Oecanthinae: Paroecanthini). Zoosystema. 42, 331–353. doi:10.5252/zoosystema2020v42a19

Castresana, J. 2000. Selection of Conserved Blocks from Multiple Alignments for Their Use in Phylogenetic Analysis. Molecular Biology and Evolution. 17, 540–552. doi:10.1093/oxfordjournals.molbev.a026334

Chintauan-Marquier, I.C., Legendre, F., Hugel, S., Robillard, T., Grandcolas, P., Nel, A., Zuccon, D., Desutter-Grandcolas, L. 2016. Laying the foundations of evolutionary and systematic studies in crickets (Insecta, Orthoptera): a multilocus phylogenetic analysis. Cladistics. 32, 54–81. doi:10.1111/cla.12114

Chopard, L. 1968. Gryllides. Fam. Gryllidae: Subf. Mogoplistinae, Myrmecophilinae, Scleropterinae, Cachoplistinae Pteroplistinae, Pentacenturinae, Phalangopsinae, Trigonidinae, Eneopierinae; Fam.Oecanthidae, Gryllotalpidae, in: Orthopterorum Catalogus. Beier, M., Gravenhage, pp. 213–500.

Chopard, L. 1936. Orthoptères fossiles et subfossiles de l'ambre et du copal. Annales de La Société Entomologique de France. 375–386.

Cigliano, M.M., Braun, H., Eades, D.C., Otte, D. 2022. Orthoptera Species File. Version 5.0/5.0 [WWW document] [WWW Document]. URL http://orthoptera.speciesfile.org (accessed 1.7.22).

Collins, N., González, I.M.C., Govaerts, B.V.A. 2019. Oecanthus mhatreae sp. nov. (Gryllidae: Oecanthinae): A new species of tree cricket from Mexico, with an irregular song pattern and unique chirp-like trill configuration. Journal of Orthoptera Research. 28, 137–143. doi:10.3897/jor.28.33781

Costello, R.A., Symes, L.B. 2014. Effects of anthropogenic noise on male signalling behaviour and female phonotaxis in Oecanthus tree crickets. Animal Behaviour. 95, 15–22. doi:10/f6gk27

Desutter, L. 1988. Structure et évolution du complexe phallique des Gryllidea (Orthoptères) et classification des genres Nèotropicaux de Grylloidea.-Deuxième Partie. Annales de la Societé entomologique de France. 24, 342–373.

Desutter, L. 1987. Structure et évolution du complexe phallique des Gryllidea (Orthoptères) et classification des genres Néotropicaux de Grylloidea. Primière Partie. Annales de La Société Entomologique de France. 23, 213–239.

Desutter-Grandcolas, L. 2003. Phylogeny and the evolution of acoustic communication in extant Ensifera (Insecta, Orthoptera). Zoologica Scripta. 32, 525–561. doi:10.1046/j.1463-6409.2003.00142.x

Desutter-Grandcolas, L., Josse, H., Laurent, M., Campos, L. D. de, Hugel, S., Nel, A., Perrichot, V. New Cretaceous crickets of the subfamilies Nemobiinae and Podoscirtinae (Orthoptera, Grylloidea: Trigonidiidae, Gryllidae) attest for the first time the antiquity of these clades. Submit.

Desutter-Grandcolas, L., Anso, J., Jourdan, H. 2016. Crickets of New Caledonia (Insecta, Orthoptera, Grylloidea): a key to genera, with diagnoses of extant genera and descriptions of new taxa. Zoosystema. 38, 405–452. doi:10.5252/z2016n4a1

Desutter-Grandcolas, L., Hugel, S., Nel, A., Warren, B.H., Souza-Dias, P., Chintauan-Marquier, I.C. 2021. Updated diagnoses for the cricket family Trigonidiidae (Insecta: Orthoptera: Grylloidea) and its subfamilies (Trigonidiinae, Nemobiinae), with a review of the fossil record. Zoologischer Anzeiger. doi:10/gk8fnb

Desutter-Grandcolas, L., Jacquelin, L., Hugel, S., Boistel, R., Garrouste, R., Henrotay, M., Warren, B.H., Chintauan-Marquier, I.C., Nel, P., Grandcolas, P., Nel, A. 2017. 3-D imaging reveals four extraordinary cases of convergent evolution of acoustic communication in crickets and allies (Insecta). Scientific Reports. 7, 1–8. doi:10.1038/s41598-017-06840-6

Desutter-Grandcolas, L., Robillard, T. 2003. Phylogeny and the evolution of calling songs in Gryllus (Insecta, Orthoptera, Gryllidae). Zoologica Scripta. 32, 173–183. doi:10.1046/j.1463-6409.2003.00107.x

Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N.D., Wikramanayake, E., Hahn, N., Palminteri, S., Hedao, P., Noss, R., Hansen, M., Locke, H., Ellis, E.C., Jones, B., Barber, C.V., Hayes, R., Kormos, C., Martin, V., Crist, E., Sechrest, W., Price, L., Baillie, J.E.M., Weeden, D., Suckling, K., Davis, C., Sizer, N., Moore, R., Thau, D., Birch, T., Potapov, P., Turubanova, S., Tyukavina, A., De Souza, N., Pintea, L., Brito, J.C., Llewellyn, O.A., Miller, A.G., Patzelt, A., Ghazanfar, S.A., Timberlake, J., Klöser, H., Shennan-Farpón, Y., Kindt, R., Lillesø, J.P.B., Van Breugel, P., Graudal, L., Voge, M., Al-Shammari, K.F., Saleem, M. 2017. An Ecoregion-

Based Approach to Protecting Half the Terrestrial Realm. Bioscience. 67, 534–545. doi:10.1093/biosci/bix014

Dong, J., Kergoat, G.J., Vicente, N., Rahmadi, C., Xu, S., Robillard, T. 2018. Biogeographic patterns and diversification dynamics of the genus Cardiodactylus Saussure (Orthoptera, Grylloidea, Eneopterinae) in Southeast Asia. Molecular Phylogenetics and Evolution. 129, 1–14. doi:10.1016/j.ympev.2018.06.001

Drummond, A.J., Ho, S.Y.W., Phillips, M.J., Rambaut, A. 2006. Relaxed Phylogenetics and Dating with Confidence. PLOS Biology. 4, e88. doi:10.1371/journal.pbio.0040088

Edwards, E.J., Osborne, C.P., Strömberg, C.A.E., Smith, S.A., null, null, Bond, W.J., Christin, P.-A., Cousins, A.B., Duvall, M.R., Fox, D.L., Freckleton, R.P., Ghannoum, O., Hartwell, J., Huang, Y., Janis, C.M., Keeley, J.E., Kellogg, E.A., Knapp, A.K., Leakey, A.D.B., Nelson, D.M., Saarela, J.M., Sage, R.F., Sala, O.E., Salamin, N., Still, C.J., Tipple, B. 2010. The Origins of C_4 Grasslands: Integrating Evolutionary and Ecosystem Science. Science. 328, 587–591. doi:10.1126/science.1177216

Ewing, B., Green, P. 1998. Base-Calling of Automated Sequencer Traces Using Phred. II. Error Probabilities. Genome Research. 8, 186–194. doi:10.1101/gr.8.3.186

Ewing, B., Hillier, L., Wendl, M.C., Green, P. 1998. Base-Calling of Automated Sequencer Traces UsingPhred. I. Accuracy Assessment. Genome Research. 8, 175–185. doi:10.1101/gr.8.3.175

Fabreti, L.G., Höhna, S. 2021. Convergence Assessment for Bayesian Phylogenetic Analysis using MCMC simulation. bioRxiv. 2021.05.04.442586. doi:10/gk7vpc

Farris, J.S. 1989. The retention index and the rescaled consistency index. Cladistics. 5, 417–419. doi:10.1111/j.1096-0031.1989.tb00573.x

Farris, J.S., Albert, V.A., Källersjö, M., Lipscomb, D., Kluge, A.G. 1996. Parsimony Jackknifing out performs neighbor-joining. Cladistics. 12, 99–124. doi:10.1006/clad.1996.0008

Felsenstein, J. 1985. Confidence Limits on Phylogenies: An Approach Using the Bootstrap. Evolution. 39, 783–791. doi:https://doi.org/10.1111/j.1558-5646.1985.tb00420.x

Galtier, N., Gouy, M., Gautier, C. 1996. SEAVIEW and PHYLO_WIN: two graphic tools for sequence alignment and molecular phylogeny. Bioinformatics. 12, 543–548. doi:10.1093/bioinformatics/12.6.543

Gamble, T., Bauer, A.M., Greenbaum, E., Jackman, T.R. 2008. Evidence for Gondwanan vicariance in an ancient clade of gecko lizards. Journal of Biogeography. 35, 88–104. doi:10/drn3wr

Gavryushkina, A., Welch, D., Stadler, T., Drummond, A.J. 2014. Bayesian Inference of Sampled Ancestor Trees for Epidemiology and Fossil Calibration. PLOS Computational Biology. 10, e1003919. doi:10.1371/journal.pcbi.1003919

Gerhardt, H.C., Huber, F. 2002. Acoustic communication in insects and anurans: common problems and diverse solutions. University of Chicago Press.

Giribet, G., Carranza, S., Riutort, M., Baguñà, J., Ribera, C. 1999. Internal phylogeny of the Chilopoda (Myriapoda, Arthropoda) using complete 18S rDNA and partial 28S rDNA sequences. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. 354, 215–222. doi:10.1098/rstb.1999.0373

Goloboff, P.A., Catalano, S.A. 2016. TNT version 1.5, including a full implementation of phylogenetic morphometrics. Cladistics. 32, 221–238. doi:10.1111/cla.12160

Gordon, D., Green, P. 2013. Consed: a graphical editor for next-generation sequencing. Bioinformatics. 29, 2936–2937. doi:10.1093/bioinformatics/btt515

Gorochov, A. 1985. On the fauna of Grylloidea (Orthoptera) of China. Entomologicheskoe Obozrenie. 64, 89–109.

Gorochov, A.V. 2020. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 12: new taxa of the subtribe Truljaliina subtrib. nov. from Africa. Zoosystematica Rossica. 29, 247–257. doi:10.31610//zsr/2020.29.2.247

Gorochov, A.V. 2018. The cricket subfamily Podoscirtinae (Orthoptera: Gryllidae) in Peru. Zoosystematica Rossica. 27, 77–121. doi:10.31610/zsr/2019.28.1.51

Gorochov, A.V. 2017. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 11: the tribe Hapithini and other American taxa. Zoosystematica Rossica. 26, 11–106.

Gorochov, A.V. 2015. Evolution and taxonomic significance of the copulatory apparatus in Ensifera (Orthoptera). Part 2: Male genitalia in Grylloidea. Zoosystematica Rossica. 24, 31–41. doi:10.31610/zsr/2015.24.1.31

Gorochov, A.V. 2013. Taxonomy of Podoscirtinae (Orthoptera : Gryllidae). Part 10 : American taxa of the tribe Aphonoidini. Zoosystematica Rossica. 22, 15–58.

Gorochov, A.V. 2010. New and little known orthopteroid insects (Polyneoptera) from fossil resins: Communication 3. Paleontological Journal. 44, 434–450. doi:10/d3k3p4

Grant, P.R., Grant, B.R., Huey, R.B., Johnson, M.T.J., Knoll, A.H., Schmitt, J. 2017. Evolution caused by extreme events. Philosophical Transactions of the Royal Society B: Biological Sciences. 372, 20160146. doi:10.1098/rstb.2016.0146

Gwynne, D.T. 2001. Katydids and bush-crickets: reproductive behavior and evolution of the Tettigoniidae. Cornell University Press.

Gwynne, D.T., Morris, G.K. 1983. Orthopteran mating systems. Westview Press.

He, Z.-Q., Shen, C.-Z., Wu, X. 2020. The first phylogenetic study of sword-tail crickets from China inferred from COI, 18S and 28S genes, with the establishment of two new genera and description of one new species (Orthoptera: Grylloidea: Trigonidiidae). Zootaxa. 4890, 119-128-119–128. doi:10/gmsfhw

Heads, S.W. 2010. The first fossil spider cricket (Orthoptera: Gryllidae: Phalangopsinae): 20 million years of troglobiomorphosis or exaptation in the dark?. Zoological Journal of the Linnean Society. 158, 56–65. doi:10.1111/j.1096-3642.2009.00587.x

Heads, S.W., Penney, D., Green, D.I. 2012. A new fossil cricket of the genus *Proanaxipha* in Miocene amber from the Dominican Republic (Orthoptera, Gryllidae, Pentacentrinae). ZooKeys. 111–118. doi:10.3897/zookeys.229.3678

Heath, T.A., Huelsenbeck, J.P., Stadler, T. 2014. The fossilized birth–death process for coherent calibration of divergence-time estimates. Proceedings of the National Academy of Sciences. 111, E2957–E2966. doi:10.1073/pnas.1319091111

Hedwig, B. 2014. Insect hearing and acoustic communication. Springer, Cambridge.

Hoang, D.T., Chernomor, O., von Haeseler, A., Minh, B.Q., Vinh, L.S. 2018. UFBoot2: Improving the Ultrafast Bootstrap Approximation. Molecular Biology and Evolution. 35, 518–522. doi:10.1093/molbev/msx281

Huang, Y., Ortí, G., Sutherlin, M., Duhachek, A., Zera, A. 2000. Phylogenetic relationships of North American field crickets inferred from mitochondrial DNA data. Molecular Phylogenetics and Evolution. 17, 48–57. doi:10.1006/mpev.2000.0815

Huber, F., Moore, T.E., Loher, W. 1989. Cricket Behavior and Neurobiology.

Ingrisch, S. 1997. Taxonomy, stridulation and development of Podoscirtinae from Thailand. Senckenbergiana Biologica. 77, 47–75.

Jarvis, K.J., Haas, F., Whiting, M.F. 2004. Phylogeny of earwigs (Insecta: Dermaptera) based on molecular and morphological evidence: reconsidering the classification of Dermaptera. Systematic Entomology. 30, 442–453. doi:10.1111/j.1365-3113.2004.00276.x

Kalyaanamoorthy, S., Minh, B.Q., Wong, T.K.F., Von Haeseler, A., Jermiin, L.S. 2017. ModelFinder: Fast model selection for accurate phylogenetic estimates. Nature Methods. 14, 587–589. doi:10.1038/nmeth.4285

Kambhampati, S. 1995. A phylogeny of cockroaches and related insects based on DNA sequence of mitochondrial ribosomal RNA genes. Proceedings of the National Academy of Sciences. 92, 2017–2020. doi:10.1073/pnas.92.6.2017

Katoh, K., Misawa, K., Kuma, K.I., Miyata, T. 2002. MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform.. Nucleic acids research. 30, 3059–66.

Katoh, K., Standley, D.M. 2014. MAFFT: Iterative Refinement and Additional Methods. pp. 131–146. doi:10.1007/978-1-62703-646-7_8

Kluge, A.G., Farris, J.S. 1969. Quantitative Phyletics and the Evolution of Anurans. Systematic Zoology. 18, 1–32. doi:10.2307/2412407

Labadessa, R., Todisco, S. 2016. Patterns of ecology and distribution of the tree crickets *Oecanthus dulcisonans* and *O. pellucens* (Orthoptera: Gryllidae; Oecanthinae) in southern Italy. Zootaxa. 4169, 579. doi:10/f84wwd

Lake, J.A. 1991. The order of sequence alignment can bias the selection of tree topology. Molecular Biology and Evolution. 8, 378–385. doi:10.1093/oxfordjournals.molbev.a040654

Larsson, A. 2014. AliView: a fast and lightweight alignment viewer and editor for large datasets. Bioinformatics. 30, 3276–3278. doi:10.1093/bioinformatics/btu531

Lutzoni, F., Wagner, P., Reeb, V., Zoller, S. 2000. Integrating Ambiguously Aligned Regions of DNA Sequences in Phylogenetic Analyses Without Violating Positional Homology. Systematic Biology. 49, 628–651. doi:10.1080/106351500750049743

Maddison, W.P., Maddison, D.R. 2021. Mesquite: a modular system for evolutionary analysis.

Martins-Neto, R.G. 1991. Sistemática dos Ensifera (Insecta, Orthopteroida) da formação Santana, Cretáceo Inferior do Nordeste do Brasil. Acta Geologica Leopoldensia. 14, 5–162.

Matthews, R.W., Matthews, J.R. 2009. Insect behavior. Springer Science & Business Media.

Mendelson, T.C., Shaw, K.L. 2005. Rapid speciation in an arthropod. Nature. 433, 375–376. doi:10.1038/433375a

Mhatre, N., Malkin, R., Deb, R., Balakrishnan, R., Robert, D. 2017. Tree crickets optimize the acoustics of baffles to exaggerate their mate- attraction signal 1–16.

Mhatre, N., Montealegre-Z, F., Balakrishnan, R., Robert, D. 2009. Mechanical response of the tympanal membranes of the tree cricket Oecanthus henryi. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology. 195, 453–462. doi:10.1007/s00359-009-0423-x

Milach, E.M., Kátia, M., Da Costa, M., De, L., Martins, P., Nunes, L.A., Santos, D., Silva, M., Roberto, F., Garcia, M., Centeno, E., Oliveira, D., Zefa, E. 2016. New species of tree cricket Oecanthus Serville, 1831 (Orthoptera: Gryllidae: Oecanthinae) from Reserva Natural Vale, Espírito Santo, Brazil, with chromosome complement. Zootaxa. 4173, 137–146. doi:10.11646/zootaxa.4173.2.4

Nattier, R., Grandcolas, P., Elias, M., Desutter-Grandcolas, L., Jourdan, H., Couloux, A., Robillard, T. 2012. Secondary Sympatry Caused by Range Expansion Informs on the Dynamics of Microendemism in a Biodiversity Hotspot. PLOS ONE. 7, e48047. doi:10.1371/journal.pone.0048047

Nattier, R., Robillard, T., Desutter-Grandcolas, L., Couloux, A., Grandcolas, P. 2011. Older than New Caledonia emergence? A molecular phylogenetic study of the eneopterine crickets (Orthoptera: Grylloidea). Journal of Biogeography. 38, 2195–2209. doi:https://doi.org/10.1111/j.1365-2699.2011.02563.x

Nguyen, L.T., Schmidt, H.A., Von Haeseler, A., Minh, B.Q. 2015. IQ-TREE: A fast and effective stochastic algorithm for estimating maximum-likelihood phylogenies. Molecular Biology and Evolution. 32, 268–274. doi:10.1093/molbev/msu300

Nixon, K.C. 2002. WinClada ver. 1.00. 08. Published by the author, Ithaca, New York.

Olsen, G.J., Woese, C.R. 1993. Ribosomal RNA: a key to phylogeny. The FASEB Journal. 7, 113–123. doi:https://doi.org/10.1096/fasebj.7.1.8422957

Orci, K.M., Petróczki, K., Barta, Z. 2016. Instantaneous song modification in response to fluctuating traffic noise in the tree cricket *Oecanthus pellucens*. Animal Behaviour. 112, 187–194. doi:10/f78mp2

Otte, D. 1994. The crickets of Hawaii: origin, systematics, and evolution. The Orthopterists' Society, Philadelphia.

Otte, D., Alexander, R.D. 1983. The Australian crickets (Orthoptera: Gryllidae).. The Australian crickets (Orthoptera: Gryllidae).

Otte, D., Pérez-Gelabert, D.E. 2009. Caribbean crickets. Orthopterists' Society.

Penney, D., Wheater, C.P., Selden, P.A. 2003. Resistance of Spiders to Cretaceous-Tertiary Extinction Events. Evolution. 57, 2599–2607. doi:10/cxbwrj

Pollack, G.S., Mason, A.C., Popper, A.N., Editors, R.R.F. 2016. Insect hearing. Springer International Publishing. doi:10.1007/978-3-319-28890-1

Rambaut, A., Drummond, A.J., Xie, D., Baele, G., Suchard, M.A. 2018. Posterior Summarization in Bayesian Phylogenetics Using Tracer 1.7. Systematic Biology. 67, 901–904. doi:10/gdf52n

Ramírez-Barahona, S., Sauquet, H., Magallón, S. 2020. The delayed and geographically heterogeneous diversification of flowering plant families. Nature Ecology & Evolution. 4, 1232–1238. doi:10.1038/s41559-020-1241-3

Ritchie, M.G., Garcia, C.M. 2005. Evolution of Species: Explosive speciation in a cricket. Heredity. 95, 5–6. doi:10.1038/sj.hdy.6800690

Robillard, T. 2021. Le rôle de la taxonomie et de l'histoire naturelle dans l'étude de l'évolution des grillons Eneopterinae, in: Grandcolas, P., Maurel, M.-C. (Eds.), Systématique et Exploration Du Vivant. Phi, Surrey, pp. 37–62.

Robillard, T., Desutter-Grandcolas, L. 2006. Phylogeny of the cricket subfamily Eneopterinae (Orthoptera, Grylloidea, Eneopteridae) based on four molecular loci and morphology. Molecular Phylogenetics and Evolution. 40, 643–661. doi:10.1016/j.ympev.2005.10.019

Robillard, T., Desutter-Grandcolas, L. 2004. Phylogeny and the modalities of acoustic diversification in extant Eneopterinae (Insecta, Orthoptera, Grylloidea, Eneopteridae). Cladistics. 20, 271–293. doi:10.1111/j.1096-0031.2004.00025.x

Sanmartíin, I., Ronquist, F. 2004. Southern Hemisphere Biogeography Inferred by Event-Based Models: Plant versus Animal Patterns. Systematic Biology. 53, 216–243.

Sanno, R., Kataoka, K., Hayakawa, S., Ide, K., Nguyen, C.N., Nguyen, T.P., Le, B.T.N., Kim, O.T.P., Mineta, K., Takeyama, H., Takeda, M., Sato, T., Suzuki, T., Yura, K., Asahi, T. 2021. Comparative Analysis of Mitochondrial Genomes in Gryllidea (Insecta: Orthoptera): Implications for Adaptive Evolution in Ant-Loving Crickets. Genome Biology and Evolution. 13. doi:10.1093/gbe/evab222

Saussure, H. de. 1878. Melanges orthopterologiques: gryllides. VI. fascicule Gryllides.. Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. 25, 369–704.

Schubnel, T., Desutter-Grandcolas, L., Legendre, F., Prokop, J., Mazurier, A., Garrouste, R., Grandcolas, P., Nel, A. 2019. To be or not to be: postcubital vein in insects revealed by microtomography. Systematic Entomology. 1–10. doi:10.1111/syen.12399

Sereno, P.C. 2007. Logical basis for morphological characters in phylogenetics. Cladistics. 23, 565–587. doi:10.1111/j.1096-0031.2007.00161.x

Shaw, K.L. 2002. Conflict between nuclear and mitochondrial DNA phylogenies of a recent species radiation: What mtDNA reveals and conceals about modes of speciation in Hawaiian crickets. Proceedings of the National Academy of Sciences. 99, 16122–16127. doi:10.1073/pnas.242585899

Shen, C.-Z., Guo, P.-K., He, Z.-Q. 2020. A pilot phylogeny study of Nemobiinae inferred from 18S, 28s and COI genes, with descriptions of two new genera and a new species from Hainan, China (Orthoptera: Grylloidea: Trigonidiidae). Zootaxa. 4778, 383–390. doi:10.11646/zootaxa.4778.2.9

Short, A.E.Z., Girón, J.C., Toussaint, E.F.A. 2021. Evolution and biogeography of acidocerine water scavenger beetles (Coleoptera: Hydrophilidae) shaped by Gondwanan vicariance and Cenozoic isolation of South America. Systematic Entomology. 46, 380–395. doi:10/gmjbg4

Šipoš, J., Kindlmann, P. 2013. Effect of the canopy complexity of trees on the rate of predation of insects. Journal of Applied Entomology. 137, 445–451. doi:10/f4zwwp

Sismondo, E. 1993. Ultrasubharmonic resonance and nonlinear dynamics in the song of *Oecanthus nigricornis* F. Walker (Orthoptera : Gryllidae). International Journal of Insect Morphology and Embryology. 22, 217–231. doi:10.1016/0020-7322(93)90011-O

Song, H., Amédégnato, C., Cigliano, M.M., Desutter-Grandcolas, L., Heads, S.W., Huang, Y., Otte, D., Whiting, M.F. 2015. 300 million years of diversification: elucidating the patterns of orthopteran evolution based on comprehensive taxon and gene sampling. Cladistics. 31, 621–65. doi:10.1111/cla.12116

Song, H., Béthoux, O., Shin, S., Donath, A., Letsch, H., Liu, S., McKenna, D.D., Meng, G., Misof, B., Podsiadlowski, L., Zhou, X., Wipfler, B., Simon, S. 2020. Phylogenomic analysis sheds light on the evolutionary pathways towards acoustic communication in Orthoptera. Nature Communications. 2020, 4939. doi:10.1038/s41467-020-18739-4

Souza-Dias, P.G.B. de. 2015. Análise cladística e morfologia do complexo fálico de Phalangopside, com ênfase em Luzarinae (Orthoptera, Ensifera, Grylloidea) (PhD Thesis). Universidade de São Paulo - Instituto de Biociências, São Paulo.

Swofford, D.L., Olsen, G.J., Waddell, P.J., Hillis, D.M. 1996. Phylogenetic inference, in: Hillis, D.M., Moritz, C., Mable, B.K. (Eds.), Molecular Systematics. Sinauer, Sunderland, Mass, pp. 407–514.

Tan, M.K., Malem, J., Legendre, F., Dong, J., Baroga-Barbecho, J.B., Yap, S.A., Wahab, R. bin H.A., Japir, R., Chung, A.Y.C., Robillard, T. 2021. Phylogeny, systematics and evolution of calling songs of the Lebinthini crickets (Orthoptera, Grylloidea, Eneopterinae), with description of two new genera. Systematic Entomology. 46, 1060–1087. doi:10/gmsd9r

Toussaint, E.F.A., Bloom, D., Short, A.E.Z. 2017. Cretaceous West Gondwana vicariance shaped giant water scavenger beetle biogeography. Journal of Biogeography. 44, 1952–1965. doi:10/gbvjqg

Vaidya, G., Lohman, D.J., Meier, R. 2011. SequenceMatrix: concatenation software for the fast assembly of multi-gene datasets with character set and codon information. Cladistics. 27, 171–180. doi:10.1111/j.1096-0031.2010.00329.x

Vaughan, T.G. 2017. IcyTree: rapid browser-based visualization for phylogenetic trees and networks. Bioinformatics. 33, 2392–2394. doi:10.1093/bioinformatics/btx155

Vicente, N., Kergoat, G.J., Dong, J., Yotoko, K., Legendre, F., Nattier, R., Robillard, T. 2017. In and out of the Neotropics: historical biogeography of Eneopterinae crickets. Journal of Biogeography. 44, 2199–2210. doi:10.1111/jbi.13026

Walker, T.J., Collins, N. 2010. New World thermometer crickets: the *Oecanthus rileyi* species group and a new species from North America. Journal of Orthoptera Research. 19, 371–376. doi:10/d8s5x9

Wang, H., Fang, Y.N., Fang, Y., Jarzembowski, E.A., Wang, B., Zhang, H.C. 2019. The earliest fossil record of true crickets belonging to the Baissogryllidae (Insecta , Orthoptera , Grylloidea) 10–14.

Whiting, M.F. 2002. Mecoptera is paraphyletic: multiple genes and phylogeny of Mecoptera and Siphonaptera. Zoologica Scripta. 31, 93–104. doi:10.1046/j.0300-3256.2001.00095.x

Wills, M.A. 1999. Congruence Between Phylogeny and Stratigraphy: Randomization Tests and the Gap Excess Ratio. Systematic Biology. 48, 559–580. doi:10/dsv3wf

Xu, C., Zhang, H., Jarzembowski, E.A., Fang, Y. 2020. The first ground cricket (Orthoptera: Trigonidiidae: Nemobiinae) from mid-Cretaceous Burmese amber. Cretaceous Research. 115, 104481. doi:10.1016/j.cretres.2020.104481

Zeuner, F.E. 1937. Descriptions of New Genera and Species of Fossil Saltatoria (Orthoptera). Proceedings of the Royal Entomological Society of London. Series B, Taxonomy. 6, 154–159. doi:10.1111/j.1365-3113.1937.tb00314.x

Appendix 1 – Morphological characters list

Head

1. Head, lateral ocelli: absent (0), present (1) (Fig. S1A, B)

2. If 1(1), head, lateral ocelli, position: dorsal (0) (Fig. S1A), frontal (1) (Fig. S1C).

3. If 1(1), head, lateral ocelli, shape: rounded (0) (Fig. S1A), elliptical (1) (Fig. S1B).

4. Head, median ocellus: absent (0), present (1) (Fig. S1A).

5. If 4(1), head, median ocellus, shape: elliptical (0) (Fig. S1B), rounded (1) (Fig. S1A).

Character observed in frontal view.

6. If 4(1), head, median ocellus, ventral margin: not truncated (0), truncated (1) (Fig. S1C).

Character observed in frontal view.

7. If 4(1), head, median ocellus, size: smaller than lateral ocelli (0) (Fig. S1A), same size as lateral ocelli (1) (Fig. S1B).

8. If 4(1), head, median ocellus, position: facial (0) (Fig. S1C), dorsal (1) (Fig. S1A).

Character from Robillard and Desutter-Grandcolas (2004).

9. If 1(1) and 4(1), head, ocelli, median and lateral, position: not aligned (0) (Fig. S1A), aligned (1) (Fig. S1C, D).

10. If 1(1) and 4(1), head, ocelli, median and lateral: not connected (0) (Fig. S1A), connected (1) (Fig. S1D).

11. Head, eyes, posterior margin in lateral view (Fig. S1E): straight (0), concave (1).

12. If 12(1), head, eyes, horizontal band: absent (0), present (1) (Fig. S1F, G).

The bands are a distinct line composed of omatids with a different pigmentation than the rest of the eye.

13. Head, eyes, number of horizontal bands: 1 (0) (Fig. S1G), 2 (1), 3 (2) (Fig. S1F).

14. Head, vertex in frontal view: almost straight (0) (Fig. S1C), rounded (1) (Fig. S1A).

15. Head, fastigium, top in frontal view: truncated (0) (Fig. S1G), not truncated (1) (Fig. S1B).

16. Head, fastigium in dorsal view (Fig. 1Ha-d): longer than wide (0), as long as wide (1), wider than long (2).

This character and character 17 are observable in dorsal view.

17. Head, fastigium, apical part (Fig. 1Hc, d): shorter than proximal (0), same length (1).

Character from Robillard and Desutter-Grandcolas (2004) (character 7).

18. Head, fastigium, double row of bristles: absent (0) (Fig. S1C), present (1) (Fig. S1A, I).

19. If 18(1), head, fastigium, double row of bristles, line disposition: aligned (0) (Fig. S1I), not aligned (1) (Fig. S1A).

20. Head, antennal scape, width related to fastigium: narrower (0) (Fig. S1C), same size or wider (1) (Fig. S1A).

Character proposed by Souza-Dias (2015).

21. Head, antennae, scape, distal tubercle: absent (0), present (1) (Fig. S1J).

22. Head, antennal socket, inner margin: not bent up (0), bent up (1) (Fig. S1B).

23. Head, antennal socket, outer margin: not bent up (0), bent up (1) (Fig. S1G).

24. Head, mouthparts, disposition: prognathous (0) (Fig. 1K), hypognathous (1) (Fig. S1F).

25. Head, maxillary palpus, 5th article, size related to 4th article: same (0) (Fig. S1A), longer (1) (Fig. S1K).

26. Head, maxillary palpus, 5th article, curvature (Fig. S1L): curved downwards (0) (Fig. S1La), curved upwards (1) (Fig. S1Lb), curved upwards 90° angle (2) (Fig. 1Lc), straight (3) (Fig. S1Ld).

27. Head, maxillary palpus, 5th article, sensilla region: apical (0) (Fig. S1Lc), ventral (1) (Fig. S1Lb), internal (2) (Fig. S1La).

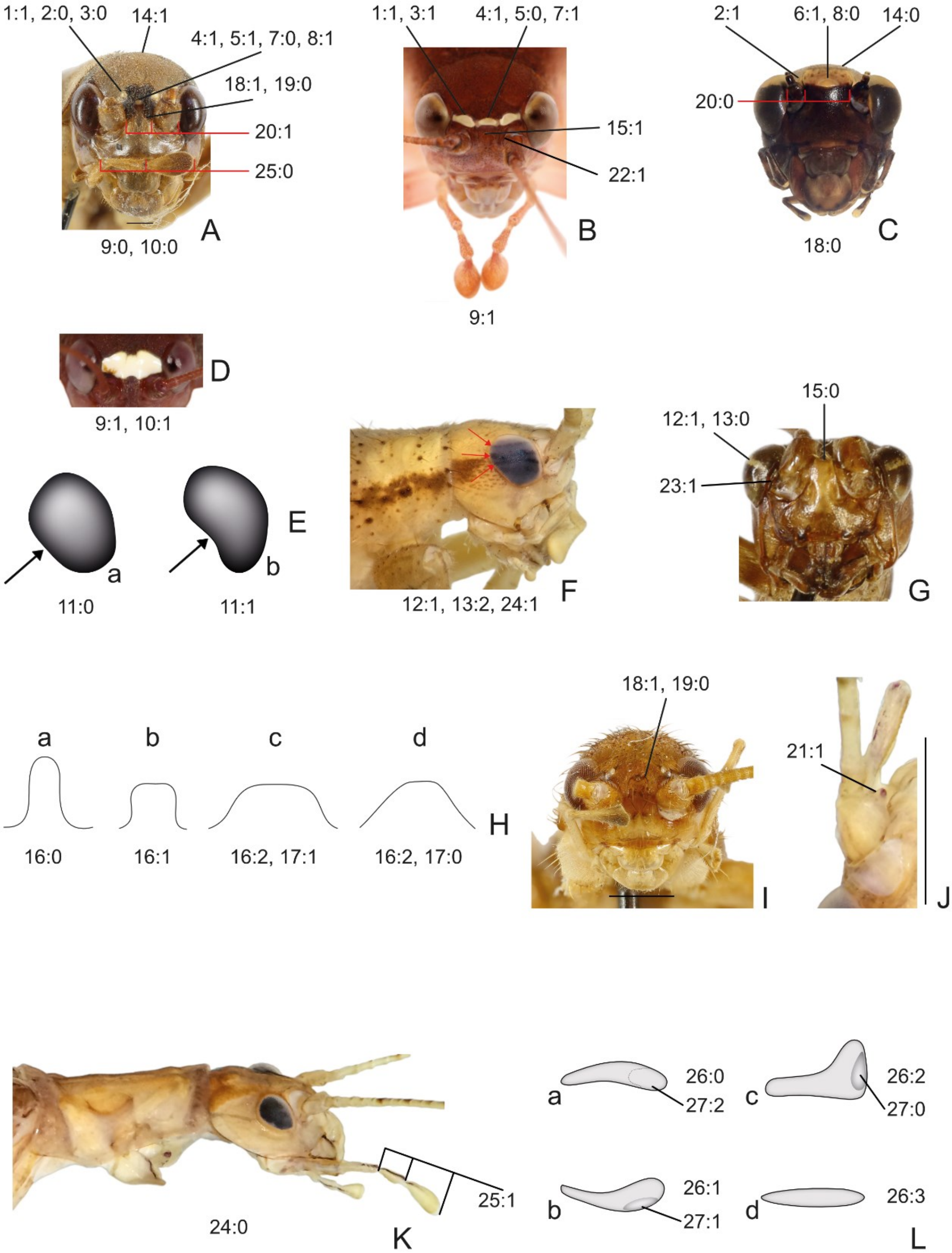


Figure S1. Frontal head: A- *Tafalisca elongata elongata*, B-*Phyllogryllus velutinus*, C-*Eneoptera surinamensis*. D-*Phyllogryllus* sp., eyes frontal; E-eyes, lateral view; F-*Cearacesa* nova, head lateral; *Euscyrtus angustifrons*, frontal head; H-fastigium, dorsal view; I-*Apterotrypa mitarakensis*, frontal head; J-*Neoxabea brevipes*, antennal scape; K-*Neoxabea brevipes*, lateral head and pronotum; maxillary palpi, 5th article lateral. Figure G available at http://coldb.mnhn.fr/catalognumber/mnhn/eo/ensif5081.

Wings

28. Forewings (FWs) and hindwings (HWs): both absent (0) (Fig. S2A), both present (1) (Fig. S2C, F), HWs absent (2) (Fig. S2B).

Both pairs of wings cannot be considered independently in crickets since HWs are always lacking when FWs are absent, the reverse is not true (Robillard and Desutter-Grandcolas, 2004).

29. If 28 (1), FW, length related to HW in dorsal view: shorter (0) (Fig. S2F), longer (1) (Fig. S2C), same size (2).

30. If 28 (1 or 2), FW, length, coverture in dorsal view: only metanotum (0) (Fig. S2B), abdomen partially, anterior half (1) (Fig. S2D), abdomen partially, posterior half (2) (Fig. S2C), abdomen totally (3) (Fig. S2F).

31. If 28 (1 or 2), FW, lateral field: absent (0) (Fig. 2B), present (1) (Fig. S2Ee).

32. If 28 (1 or 2) and 31(1), FW, lateral field, relation to dorsal field, length: same size (0) (Fig. S2H1), shorter (1) (Fig. S2H2).

Character from Robillard and Desutter-Grandcolas (2004).

33. If 28 (1 or 2) and If 31(1), FW, lateral field, veins, position of insertion on Sc: parallel to dorsal field (0) (Fig. S2Ia), perpendicular to dorsal field (1) (Fig. S2Ib).

34. If 28 (1 or 2) and 31(1), FW, lateral field, relation to dorsal field, position in posterior view: 90° (0) (Fig. S2J1), >90° (1) (Fig. S2J2).

35. If 28 (1 or 2), male, FW, anal area: absent (0) (Fig. S3A), present (1) (Fig. S2Ef).

36. If 28 (1 or 2), male, FW, PCu vein: absent (0), present (1) (Fig. S2Ea, G).

37. I 28(1 or 2) and 36(1), male, forewing, PCu vein, ventral face, stridulatory teeth: absent (0), present (1) (Fig. S2K).

38. If 28 (1 or 2) and 36(1), male, FW, dorsal field, PCu vein, shape: parallel to lateral field (0) (Fig. S3A), curved (1) (Fig. S2G).

39. If 28 (1 or 2), 36(1) and 38(1), male, FW, dorsal field, PCu vein curved: not sinuous (0) (Fig. S3Ba), sinuous (1) (Fig. S3Bb), bisinuous (2) (Fig. S3Bc).

40. If 28 (1 or 2), 36(1) and 38(1), male, FW, dorsal field, PCu vein curved, sinuosity position: on the middle (0) (Fig. S3Bb), close to CuPa (1) (Fig. S3Bd).

41. If 28 (1 or 2), 36(1) and 38(1), male, FW, PCu curved, angle: 90° (0) (Fig. S3Ba), more than 90° (1) (Fig. S3Bb-d).

42. If 28 (1 or 2), 36(1) and 38(1), male, FW, PCu vein curved, proximal region related to CuPa: parallel (0) (Fig. S3F), not parallel (1) (Fig. S2G).

43. If 28 (1 or 2), 36(1), 37(1) and 38(1), male, FW, PCu curved, stridulatory teeth, position: basal third (0) (Fig. S3C), mid length (1) (Fig. S2K).

All species examined here with PCu vein curved have stridulatory teeth on ventral face. Character proposed by from Robillard and Desutter-Grandcolas (2004).

44. If 28 (1 or 2), 36(1) and 38(1), male, FW, dorsal field, PCu vein curved, surrounding sclerotization: absent (0), present (1) (Fig. S3D).

45. If 28 (1 or 2), male, FW, dorsal field, harp veins (hv): absent (0), present (1) (Fig. S2Eb, G).

46. If 28 (1 or 2) and 45(1), male, FW, hv, shape: curved (0) (Fig. 2G), v-shaped (1) (Fig. S3E).

47. If 28 (1 or 2) and 45(1), male, FW, dorsal field, hv, position: diagonal (0) (Fig. S2G, S3E), parallel to PCu vein (1) (Fig. 3G).

48. If 28 (1 or 2) and 45(1), male, FW, dorsal field, hv, division: one cluster (0) (Fig. S2G), two clusters (1) (Fig. S3F).

49. If 28 (1 or 2) and 45(1), male, FW, hv, number: one (0) (Fig. 3E), two (1) (Fig. S3G), more than two (2) (Fig. S2G).

50. If 28 (1 or 2) and 45(1), male, FW, hv, proximal connection: absent (0) (Fig. S2G), present (1) (Fig. S3D).

51. If 28 (1 or 2) and 45(1), male, FW, hv, connection with CuPa: absent (0) (Fig. S3D), present (1) (Fig. S2G).

52. If 28 (1 or 2), male, FW, CuPb: absent (0), present (1) (Fig. S2G).

53. If 28 (1 or 2) and 52(1), male, FW, CuPb, size: shorter than PCu curve (0) (Fig. S3D), longer than PCu curve (1) (Fig. S3H).

54. If 28 (1 or 2), 41(1) and 52(1), male, FW, hv, connection to CuPb: absent (0), present (1) (Fig. S3H).

55. If 28 (1 or 2) and 52(1), male, FW, CuPb, connection with CuPa: absent (0), present (1) (Fig. S3H).

56. If 28 (1 or 2) and 52(1), male, FW, CuPb, position related to CuPa: side by side (0) (Fig. S3H), above in lateral view (1).

57. If 28 (1 or 2), male, FW, M+CuA, proximal region glandular: absent (0), present (1) (Fig. S3I).

58. If 28 (1 or 2), FW, M+Cua and R connection by accessory veins: absent (0), present (1) (Fig. S2G).

59. If 28 (1 or 2), FW, space between M+CuA and R, coloration: same coloration of the wing (0), whitish (1).

60. If 28 (1 or 2), FW, M+CuA and R connection: absent (0), present (1) (Fig. S2G).

61. If 28 (1 or 2) and 60(1), FW, M+CuA and R connected, branches after connection: 1 (0) (Fig. S2G), 2 (1).

62. If 28 (1 or 2), male, FW, mirror: absent (0), present (1) (Fig. S2Ec, G).

63. If 28 (1 or 2) and 62(1), male, FW, mirror, crossing veins, number: 1 (0) (Fig. S2G), 2 (1) (Fig. S3H).

All analyzed specimens with mirror have at least one crossing vein.

64. If 28 (1 or 2) and 62(1), male, FW, mirror, two crossing veins, disposition: not parallel (0), parallel (1) (Fig. S3H).

65. If 28 (1 or 2) and 62(1), male, FW, dorsal field, dived mirror, vein: straight (0) (Fig. S3H), curved (1) (Fig. S2G), angled (2) (Fig. S3G).

66. If 28 (1 or 2), 62(1) and 65(1 or 2), male, FW, dorsal field, mirror, divided vein curved or angled, region: on the middle (0) (Fig. S3E), close to lateral field (1) (Fig. S3G).

67. If 28 (1 or 2), male, FW, diagonal vein: absent (0), present (1) (Fig. S2G).

68. If 28 (1 or 2), male, FW, apical field: absent (0), present (1) (Fig. S2Ed).

69. If 28 (1 or 2) and 68(1), male, FW, apical field, delimitation: not delimited (0) (Fig. S3A), delimited (1) (Fig. S3F).

70. If 28 (1 or 2), 62(1), and 68(1), male, FW, apical field, size related to the mirror: shorter (0) (Fig. S2E), same size or longer (1) (Fig. S3F).

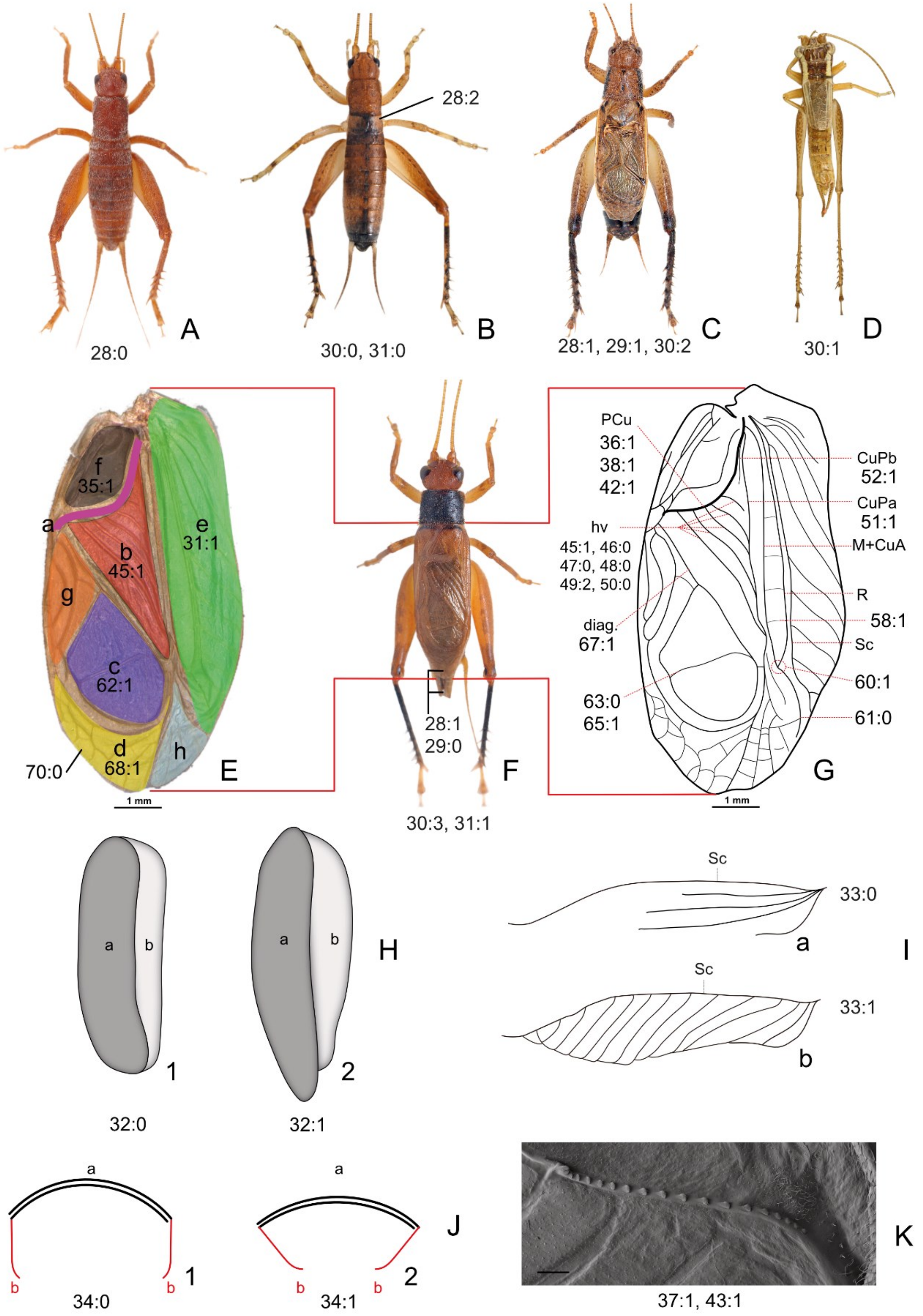


Figure S2. Dorsal habitus: A-*Neometrypus couriae*, B-*Neometrypus marcelae*, *Veredatrypa rosai*, *Euscyrtus bipunctatus*. *Diatrypa* (*Diatrypa*) *tuberculata*: E-right forewing: a-PCu vein (stridulatory file), b-harp, c-mirror, d-apical field, e-lateral field, f-anal area, g-chordal area, h-median fan; F-dorsal habitus; G-right forewing. H-right forewing: a-dorsal field, b-lateral field. I-lateral field, veins; J-right and left forewings, posterior view: a-dorsal field, b-lateral field. K-*Diatrypa* (*Diatrypa*) *tuberculata*, PCu vein, ventral (scale 200 µm). Abbreviations: see material and methods.

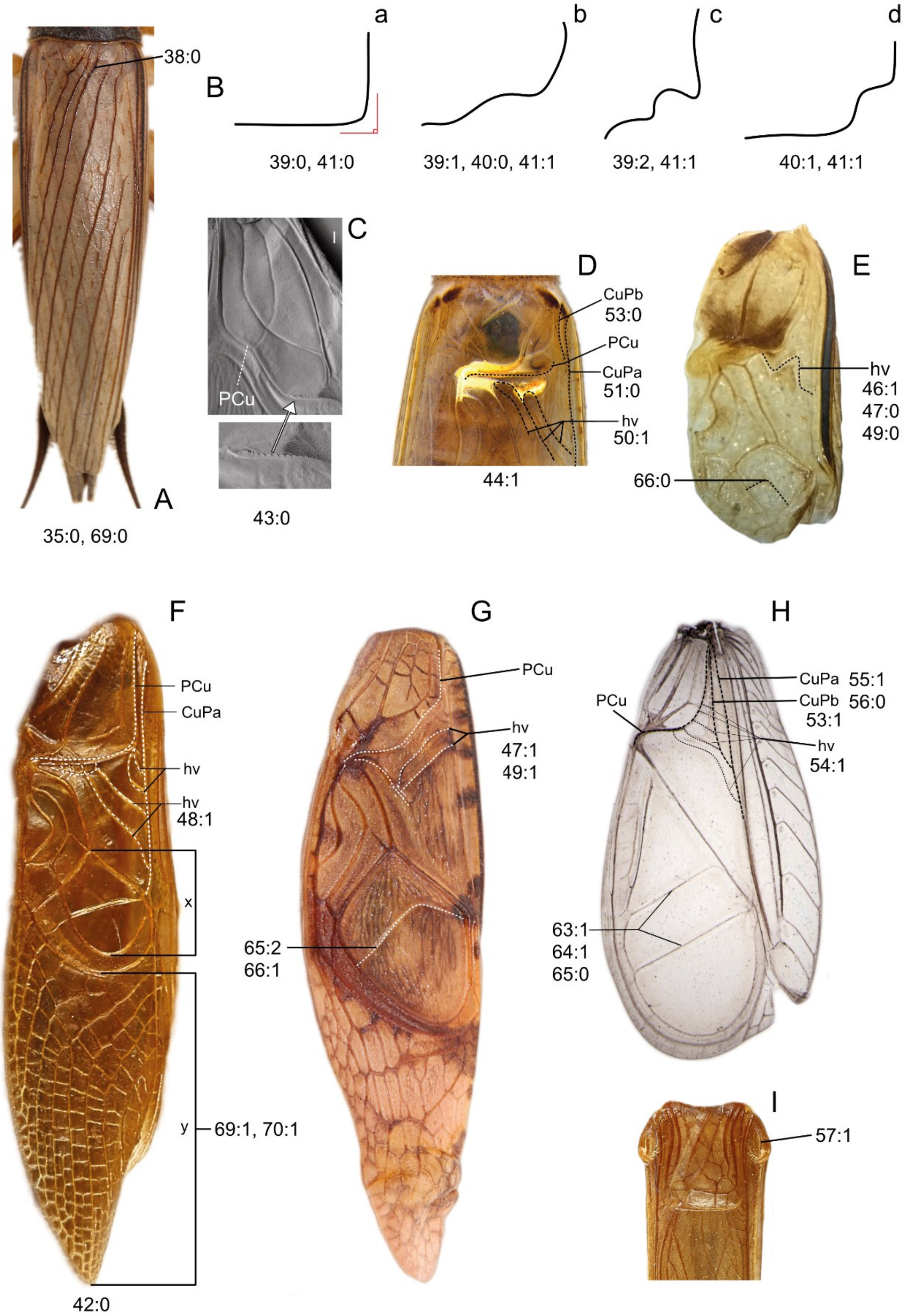


Figure S3. A-*Tafalisca elongata elongata*, dorsal forewings; B-PCu veins; C-*Hapithus* (*Antillicharis*) sp. PCu vein, ventral; D-*Veredatrypa seca*, forewings proximal margin; E-*Ligypterus linharensis*, right forewings; F-*Fryerius* sp, right forewing; G-*Phyllogryllus velutinus*, right forewing; H-*Oecanthus* sp., right forewing; I-*Archenopterus* sp., forewings proximal margin. Abbreviations: see material and methods.

Thorax

71. Pronotum, DD, size: wider than long (0) (Fig. S4Aa), longer than wide (1) (Fig. S4Ab, c), as wide as long (2) (Fig. S4Ad).

72. Pronotum, DD, caudal margin: concave (0) (Fig. S4Ad), convex (1) (Fig. S4Aa, b), straight (2) (Fig. S4Ac).

Character observable in dorsal view.

73. If 72(1), pronotum, DD, caudal margin, convex region: entire caudal margin (0) (Fig. S4Ab), central region of caudal margin (1) (Fig. S4Aa).

74. Pronotum, DD, lateral view: not flattened (0) (Fig. S4Ba), flattened (1) (Fig. S4Bb).

75. Male, metanotum, latero anterior region: not inflated (0), inflated (1) (Fig. S4C-D).

76. If 72(1), male, metanotum, antero-lateral region inflated, bristles: absent (0) (Fig. S4D, E), present (1) (Fig. S4C).

77. Male, metanotum, central fossa: absent (0), present (1) (Fig. S4C).

78. Male, metanotum, central cluster of bristles: absent (0), present (1) (Fig. S4C).

79. Male, metanotum, median projection: absent (0), present (1) (Fig. S4C, E).

80. If 79(1), male, metanotum, median projections, division: single (0) (Fig. S4E), paired (1) (Fig. S4C).

81. Male, metanotum, pair of apertures: absent (0), present (1) (Fig. S4D).

82. Male, metanotum related to posterior border of pronotum: not covered (0), covered (1) (Fig. S4F).

Abdomen

83. Abdomen, cerci, size related to FII: shorter (0) (Fig. S4G), same size or longer (1) (Fig. S4H).

84. Male, abdomen, first abdominal tergite, dorsal view, median projections: absent (0), present (1) (Fig. S4E).

85. Male, abdomen, subgenital plate, posterior margin, shape: convex (0) (Fig. S4Ia), straight (1) (Fig. S4Ib), pointed (2) (Fig. S4Ic), concave (3) (Fig. S4Id).

86. Female, abdomen, subgenital plate, posterior margin, median invagination: absent (0), present (1) (Fig. S4Ja).

87. Female, abdomen, subgenital plate, posterior margin: not surrounding ovipositor (0), surrounding ovipositor (1) (Fig. S4Jb).

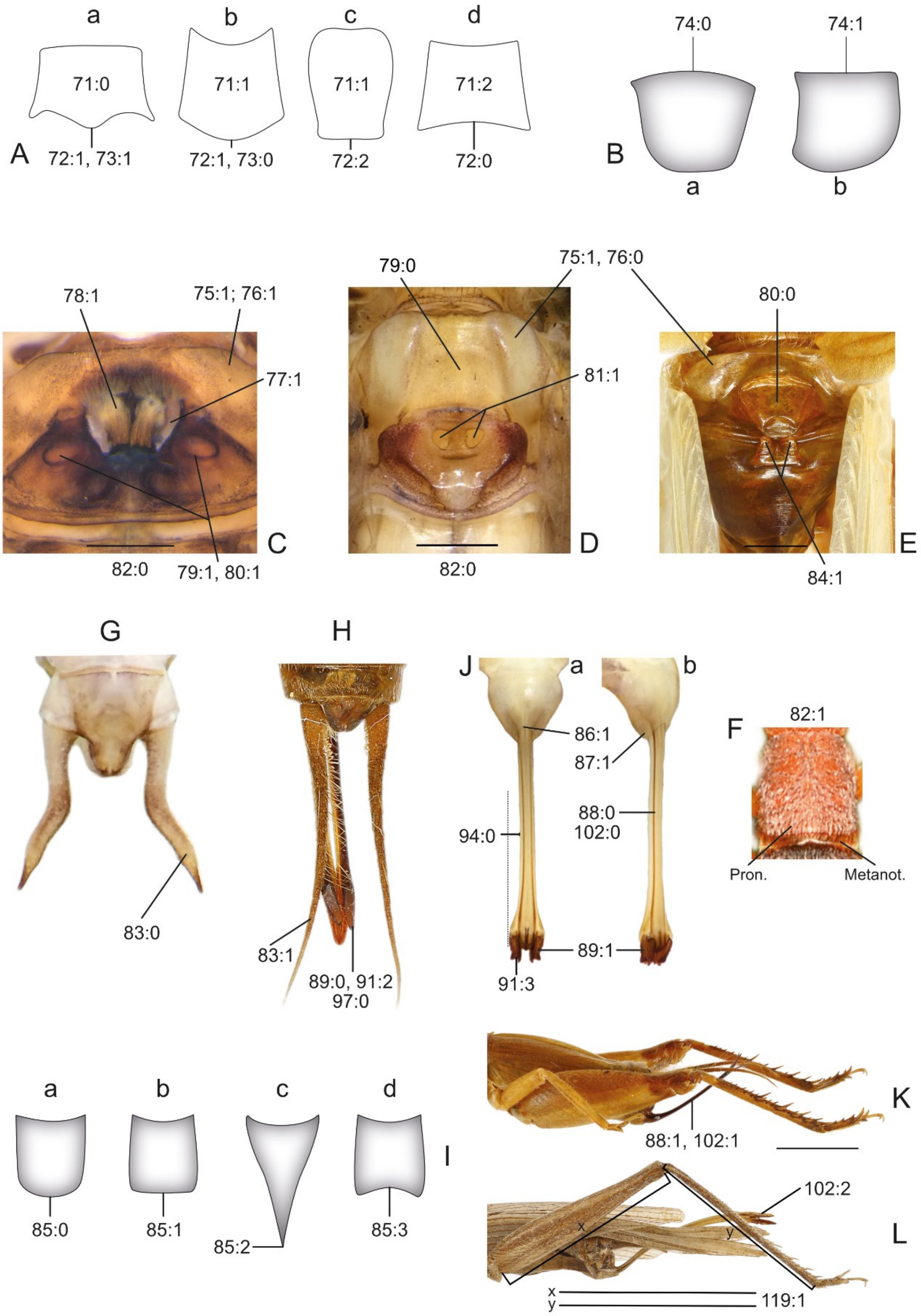


Figure S4. Pronotum: A-dorsal view; B-lateral view. Metanotum: C-*Veredatrypa rosai*, D-*Cearacesa cearensis*, E-*Brazitrypa cornuta*. F-*Apterotrypa mitarakensis*, thorax in dorsal view. Dorsal abdômen, distal: G-*Neoxabea brevipes*, H-*Apterotrypa mitarakensis*. I-subgenital plates; J-*Diatrypa* (*Diatrypa*) *tuberculata*, subgenital plate and ovipositor: a-ventral, b-lateral. Hind leg, lateral view: K-*Adenophallusia legendrei*, L-*Cearacesa cearensis*. Abbreviations: pron., pronotum; metanot., metanotum.

Ovipositor

88. Female, ovipositor, apex, form: not flattened (0) (Fig. 4J), flattened dorso-ventrally (1) (Fig. S4K), flattened laterally (2).

89. Female, ovipositor, apex, sclerotization: same sclerotization as the entire ovipositor (0) (Fig. S4H), strongly sclerotized (1) (Fig. S4J).

90. Female, ovipositor, dorsal valves (dv), apex borders in dorsal view: triangular (0) (Fig. S5A), straight (1) (Fig. S5B), curved (2) (Fig. S5C).

91. Female, ovipositor, dv, apex, tip: pointed (0) (Fig. S5E), truncated (1) (Fig. S5B), rounded (2) (Fig. S4H), forked (3) (Figs S4Ja, S5C).

92. Female, ovipositor, dv, apex, lateral serrulation: absent (0), present (1) (Fig. S5A, B, E).

93. Female, ovipositor, dv, apex, ventral serrulation: absent (0), present (1) (Fig. S5E).

94. Female, ovipositor, dv, apex, width related to the entire ovipositor in dorsal view: wider (0) (Fig. S4Ja), same width (1) (Fig. S5B).

95. Female, ovipositor, dv, apex, surface: smooth (0), wrinkled (1) (Fig. S5F).

96. Female, ovipositor, dv, apex, inner margin, bristles: absent (0), present (1) (Fig. S5G).

97. Female, ovipositor, dv apex related to ventral valves apex position: above (0) (Fig. S5B, F), outside (1) (Fig. S5A, E, G).

98. If 97(1), female, ovipositor, dv apex outside of ventral valves: covering lateral region (0) (Fig. S5D), covering lateral and ventral regions (1) (Fig. S5E).

99. Female, ovipositor, ventral valves (vv), apex, lateral margins: smooth (0), serrulated (1) (Fig. S5H).

100. Female, ovipositor, vv, tip: pointed (0) (Fig. 5E), rounded (1) (Fig. S5G), truncated (2) (Fig. S5H), forked (3) (Fig. S5D).

101. Female, ovipositor, vv, size related to dv in dorsal view: shorter (0), longer (1), same size (2).

102. Female, ovipositor, form in lateral view: straight (0) (Fig. S4J), upcurved (1) (Fig. S4K), downcurved (2) (Fig. S4L).

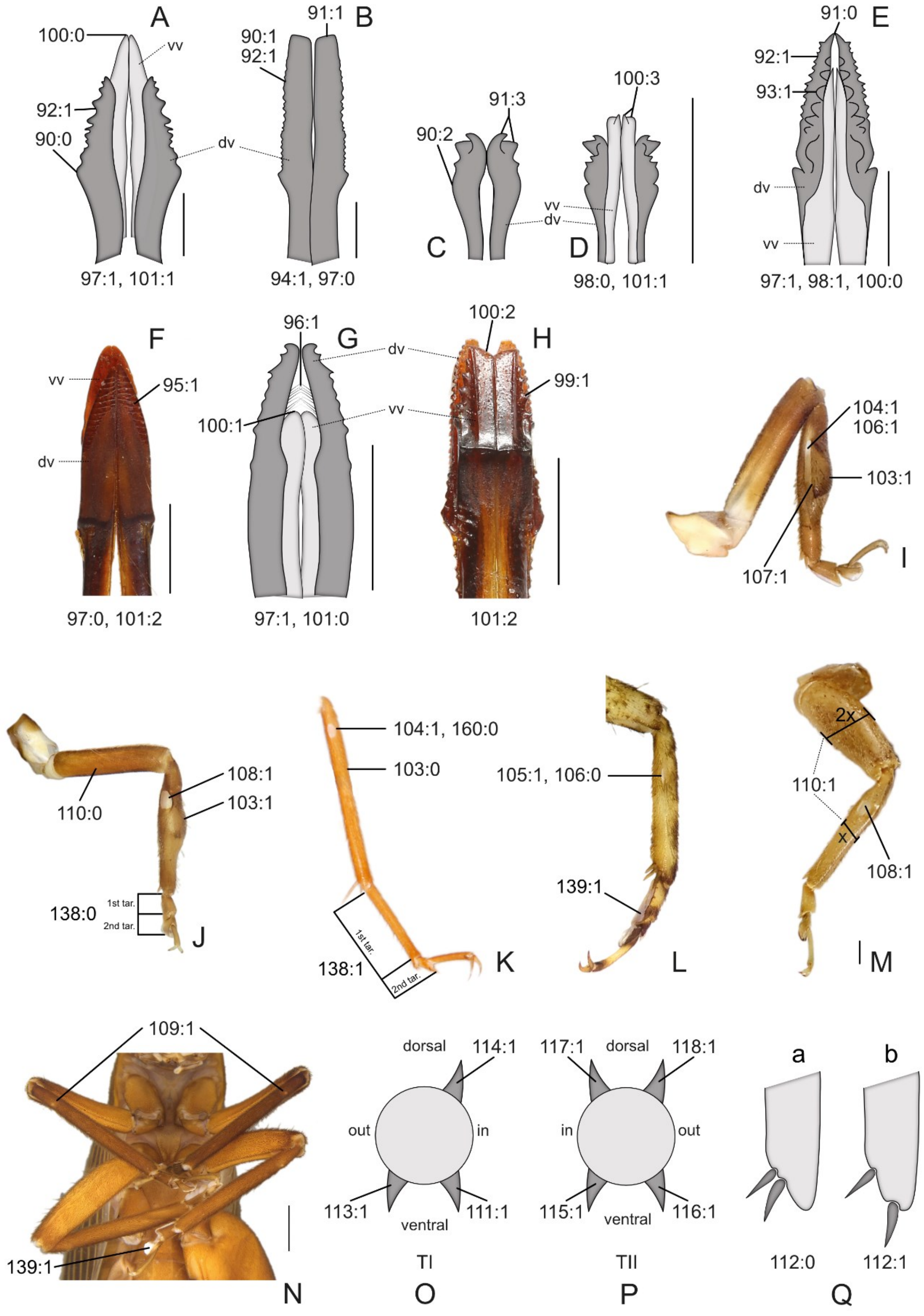


Figure S5. Ovipositor apex: A-*Phyllogryllus velutinus*, dorsal; B-*Tafalisca elongata elongata*, dorsal; C-*Diatrypa* (*Latispeculum*) *choristos*, dorsal; D-*Diatrypa* (*Latispeculum*) *choristos*, ventral; E-*Somnambula livida*, ventral; F-*Brazitrypa cornuta*, dorsal; F-*Prozvenella bangaloriensis*, dorsal; H-*Perutrella septentrionalis*, ventral. Foreleg: I-*Angistitrella mataraku*, inner face; J-*Angustitrella mataraku*, outer face; K-*Endecous* sp., inner face; L-*Ligypterus linharensis*, inner face; M-*Fryerius* sp., outer face; N-*Tafalisca duckeana*, fore and middle tibia; O-tibia I, apical; P-tibia II, apical; tibia I, lateral. Scales 1 mm. Abbreviations: see material and methods.

Legs

103. Legs, TI: not inflated (0) (Fig. S5K), inflated (1) (Fig. S5I).

104. Legs, TI, inner tympanum: absent (0), present (1) (Fig. S5I, K).

105. If 104(1), legs, TI, inner tympanum, shape: not slit-shaped (0), slit-shaped (1) (Fig. S5L).

106. If 104(1), legs, TI, inner tympanum, tympanal membrane, position: superficial (0) (Fig. S5K, L), internal (1) (Fig. S5I).

107. If 104(1), legs, TI, inner tympanum, sclerotized tab: absent (0), present (1) (Fig. S5I).

108. Legs, TI, outer tympanum: absent (0), present (1) (Fig. S5J, M).

109. Legs, TI, proximal protuberance: absent (0), present (1) (Fig. S5N).

110. Legs, FI related to TI in lateral view: similar width (0), two times wider (1) (Fig. S5M).

111. Legs, TI, apical spurs, inner ventral (Fig. S5O): absent (0), present (1).

112. Legs, TI, apical spurs, inner ventral intern, position (Fig. S5Q): ventral (0), median (1).

113. Legs, TI, apical spurs, outer ventral (Fig. S5O): absent (0), present (1).

114. Legs, TI, apical spurs, inner dorsal(Fig. S5O): absent (0), present (1).

115. Legs, TII, apical spurs, inner ventral(Fig. S5P): absent (0), present (1).

116. Legs, TII, apical spurs, outer ventral (Fig. S5P): absent (0), present (1).

117. Legs, TII, apical spurs, inner dorsal (Fig. S5P): absent (0), present (1).

Character from Robillard and Desutter-Grandcolas (2004).

118. Legs, TII, apical spurs, outer dorsal (Fig. S5P): absent (0), present (1).

119. Legs, FIII, size related to TIII: longer (0) (Fig. S6A), same size or shorter (1) (Fig. S4L).

120. Legs, TIII, subapical spurs 1, 2 and 3 (Fig. S6C): absent (0), present (1).

The subapical spurs (inner and outer) on tibia III, when present, are always three or more in crickets. They are never one or two. Subapical spurs are numbered from the most apical to the most proximal.

121. Legs, TIII, subapical spur 4, inner: absent (0) (Fig. S6C), present (1).

122. Legs, TIII, subapical spur 5, inner (Fig. S6C): absent (0), present (1).

123. Legs, TIII, subapical spur 6, inner (Fig. S6C): absent (0), present (1).

124. Legs, TIII, subapical spur 7, inner (Fig. S6C): absent (0), present (1).

125. Legs, TIII, subapical spur 8, inner (Fig. S6C): absent (0), present (1).

126. Legs, TIII, subapical spur 4, outer (Fig. S6C): absent (0), present (1).

127. Legs, TIII, subapical spur 5, outer (Fig. S6C): absent (0), present (1).

128. Legs, TIII, subapical spur 6, outer (Fig. S6C): absent (0), present (1).

129. Legs, TIII, subapical spurs, apex: straight (0), curved (1) (Fig. S6C).

130. Legs, TIII, subapical spurs, inner size related to outer: longer (0) (Fig. S6B), similar size (1) (Fig. S6C).

131. Legs, TIII, spines: absent (0), present (1) (Fig. S6C).

132. If 131(1), legs, TIII, spines, disposition: only above subapical spurs (0), above and between subapical spurs (1) (Fig. S6C).

133. Legs, TIII, apical spur, inner dorsal related to outer dorsal: similar size or slightly longer (0), three times or more longer (1) (Fig. S6D).

134. Legs, TIII, apical spur, inner ventral: absent (0), present (1) (Fig. S6D).

135. Legs, TIII, apical spur, outer ventral: absent (0), present (1) (Fig. S6D).

136. If 134(1), legs, tibia III, apical spur, inner ventral, development: well-developed (0) (Fig. S6D), very reduced (1) (Fig. S6E).

137. If 134(1), legs, TIII, apical spurs, inner, size (Fig. S6F): iad>iam (0), iad<iam (1), iad=iam (2).

138. Legs I and II, tarsomere I related to tarsomere II: same size (0) (Fig. S5J), two times or longer (1) (Fig. S5K).

139. Legs I and II, tarsomere I and II, leg III, tarsomere II, ventral region with pulvilum: absent (0) (Fig. S5K), present (1) (Fig. S5L, N).

140. Legs III, tarsomere I, dorsal spines, inner margin: absent (0), present (1) (Fig. S6C).

141. Legs III, tarsomere I, dorsal spines, outer margin: absent (0), present (1) (Fig. S6C).

142. If 140(1), legs III, tarsomere I, dorsal spines, inner margin, number: 1 (0), 2 or more (1) (Fig. S6C).

143. If 141(1), legs III, tarsomere I, dorsal spines, outer margin, number: 1 (0), 2 or more (1) (Fig. S6C).

144. Legs III, tarsomere I, inner apical spur: absent (0), present (1) (Fig. S6B, C).

145. If 144(1), legs III, tarsomere I, inner apical spur, size: same length or longer than hind tarsomere I (0) (Fig. S6B), shorter than hind tarsomere I (1) (Fig. S6C).

146. Legs III, tarsomere I, outer apical spur: absent (0), present (1) (Fig. S6B, C).

147. If 146(1), legs III, tarsomere I, outer apical spur, size: same length or longer than hind tarsomere I (0) (Fig. S6B), shorter than hind tarsomere I (1) (Fig. S6C).

148. Legs, tarsomere III, claw, inner margin, surface (Fig. S6G): smooth (0), serrulated (1).

149. Legs, tarsomere III, claws, apex (Fig. S6G): single (0), bifid (1).

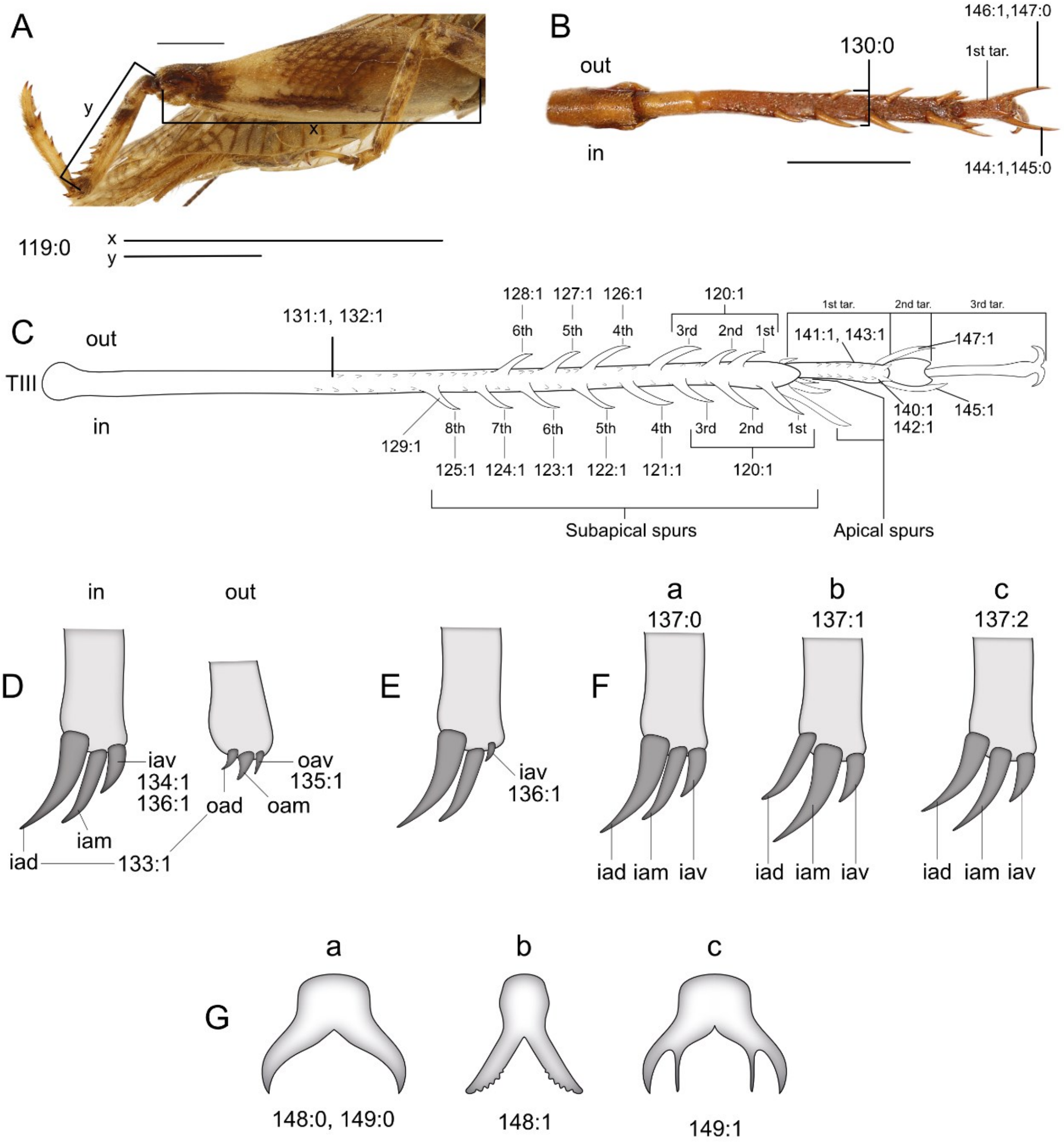


Figure S6. A-*Perutrella septentrionalis*, hind leg in lateral view; B-*Tafalisca lineatipes*, hind tibia; C-*Euscyrtinae*, hind tibia; D-tibia III, apical; E and F-tibia III apical, inner face; G-claws, inner margin. Scale 1 mm. Abbreviations: see material and methods.

Male genitalia

150. Male, genitalia, pseudepiphallic sclerite, size in dorsal view: longer than wide (0) (Fig. S7A, C), wider than long (1) (Fig. S7D).

151. Male, genitalia, pseudepiphallic sclerite, form: not capsular (0) (Fig. S7E), capsular (1) (Fig. S7F).

152. Male, genitalia, pseudepiphallic sclerite, arm: absent (0) (Fig. S7C), present (1) (Fig. S7G).

153. Male, genitalia, pseudepiphallic sclerite, LLophi: absent (0), present (1) (Fig. S7A). LLophi are interpreted as the lophi close to lateral margin of pseudepiphallic sclerite and external to MedLophi (if present).

154. If 153(1), male, genitalia, pseudepiphallic sclerite, LLophi, apex direction: posterior (0) (Fig. 7E), dorsal (1) (Fig. S7F), anterior (2) (Fig. S7H).

155. If 153(1), male, genitalia, pseudepiphallic sclerite, LLophi, inner margin: not membranous (0), membranous (1) (Fig. S7A).

156. Male, genitalia, pseudepiphallic sclerite, MedLophi: absent (0), present (1) (Fig. S7A).

MedLophi, when present, is between LLophi. When MedLophi is present, LLophi is always present. The inverse does not occur.

157. If 155(1), male, genitalia, pseudepiphallic sclerite, MedLophi, composition: single (0) (Fig. S8A), bilobate (1) (Fig. S7A).

158. If 155(1), male, genitalia, pseudepiphallic sclerite, LLophi, length: very short (0) (Fig. S8A), longer than PsP (1) (Fig. S7C).

159. If 155(1) and 154(1), male, genitalia, pseudepiphallic sclerite, MedLophi, position related to LLophi in lateral view: same line (0) (Fig. S7C), ventral (1) (Fig. S8D), dorsal (2) (Fig. S8E).

160. If 153(1) and 155(1), male, genitalia, pseudepiphallic sclerite, MedLophi and LLophi connected by membrane: absent (0) (Fig. S8D), present (1) (Fig. S7A).

161. Male, genitalia, pseudepiphallic paramere (PsP): absent (0), present (1) (Fig. S7B).

162. If 161(1), male, genitalia, PsP, development: well developed (0) (Fig. S7B), strongly reduced (1) (Fig. S8B).

163. If 161(1) and 162(0), male, genitalia, PsP, apex composition: single (0) (Fig. S7F), bilobate (1) (Fig. S7G).

164. If 161(1) and 162(0), male, genitalia, PsP, form: not cylindrical (0) (Fig. S7B, G), cylindrical (1) (Fig. S7F).

165. If 161(1), male, genitalia, PsP, position related to pseudepiphallic sclerite: ventral (0) (Fig. S7B), lateral (1) (Fig. S8C).

166. If 161(1), male, genitalia, PsP, connection with pseudepiphallic sclerite: absent (0), present (1) (Fig. S8C).

167. Male, genitalia, pseudepiphallic sclerite, anterior margin, direction: flat (0), folded dorsally (1) (Fig. S8F).

168. Male, genitalia, pseudepiphallic sclerite, pseudepiphallic apodeme (PsAp): absent (0), present (1) (Fig. S8G, H).

169. If 168(1), male, genitalia, pseudepiphallic sclerite, anterior margin, PsAp, direction in dorsal view: anterior (0) (Fig. S8G), posterior (1) (Fig. S8H).

170. Male, genitalia, rami (r), length related to pseudepiphallic sclerite: shorter or same-sized (0) (Fig. S7A), two times longer (1) (Fig. S8A).

171. Male, genitalia, r, apex: not connected (0) (Fig. 7A), connected (1) (Fig. S8I).

172. If 171(0), male, genitalia, r, apex not connected: single (0) (Fig. 8A), double (1) (Fig. S8C).

173. If 171(0), male, genitalia, r, apex not connected, shape: straight (0) (Fig. S8B), curved inward (1) (Fig. S7A, B), curved outward (2) (Fig. S8A).

174. Male, genitalia, ectophallic invagination, development: well developed (0) (Fig. S7A, B), strongly regressed (1) (Fig. S8B).

175. Male, genitalia, ectophallic invagination, arc: absent (0), present (1) (Fig. S7A, B).

176. If 175(1), male, genitalia, ectophallic invagination, arc, median region: not connected (0) (Fig. S7A, B), connected (1) (Figs S8I, S9B).

177. If 175(1) and 176(1), male, genitalia, ectophallic invagination, arc, median region not connected, apex position in lateral view: directed to inner region (0) (Fig. S8Kb), directed ventrally (1) (Fig. S8Jb).

178. If 175(1), male, genitalia, ectophallic invagination, arc, position: straight (0) (Fig. S8Jb), curved posteriorly (1) (Fig. S8A), curved anteriorly (2) (Fig. S8G).

179. If 175(1), male, genitalia, ectophallic invagination, arc, distal prolongation: absent (0), present (1) (Fig. S8G).

180. Male genitalia, ectophallic invagination, ectophallic fold (EctF): membranous (0), sclerotized (1).

181. Male, genitalia, ectophallic invagination, EctF, composition: single (0) (Fig. S8A), bilobate (1) (Figs S8C, S9A).

182. If 181(1), male, genitalia, ectophallic invagination, EctF, bilobate, apex connected: absent (0) (Fig. S9A), present (1) (Fig. S8C).

183. Male, genitalia, ectophallic invagination, EctF, single, apex, length related to pseudepiphallic sclerite posterior margin: shorter (0) (Fig. S7A), longer (1), same-sized (2) (Fig. S9B).

184. Male, genitalia, ectophallic invagination, ectophallic apodeme (EctAp): absent (0) (Fig. S9B), present (1).

185. Male, genitalia, ectophallic invagination, ventral projection (vp): absent (0), present (1) (Fig. S7A, B).

186. If 184(1) and 185(1), male, genitalia, ectophallic invagination, vp, size related to EctAp: shorter (0) (Fig. S7A, B), same size or longer (1) (Fig. S8G).

Ventral projection is a structure from ectophallic invagination posterior to the ectophallic arc (Souza-Dias, 2015; Campos *et al.*, 2021).

187. Male, genitalia, endophallus, development: well developed (0) (Fig. S7A, B), regressed (1) (Fig. S8B).

188. If 187(0), male genitalia, endophallus, shape: u-shaped (0) (Fig. S9A), not u-shaped (1) (Fig. S7A, B).

189. If 187(0), male, genitalia, endophallus, lateral margin: not folded (0), folded (1) (Fig. S8L).

190. If 187(0), male, genitalia, endophallus: not flattened (0), flattened dorso-ventrally (1) (Fig. S8H).

191. If 187(0), male genitalia, endophallus, endophallic apodeme (EndAp): absent (0), present (1) (Fig. S8L).

192. If 187(0) and 191(1), male, genitalia, endophallus, EndAp, shape: not flattened (0) (Fig. S8L), flattened laterally (1) (Fig. S9A).

193. If 187(0) and 191(1), male, genitalia, endophallus, EndAp, composition: single (0) (Fig. S9A), bilobate (1) (Fig. S8M).

194. If 187(0) and 191(1), male, genitalia, endophallus, EndAp, size: longer or same size of PsP (0) (Fig. S9A), shorter than PsP (1) (Fig. S8C), two times longer or more than PsP (2) (Fig. S7D).

195. If 187(0), male, genitalia, End, posterior projection: absent (0), present (1) (Fig. S8N, 9A).

196. If 187(0) and 195(1), male, genitalia, endophallus, posterior projection, composition: single (0) (Fig. S8N), double (1) (Fig. S9A).

197. Male, genitalia, ventral valves: absent (0), present (1) (Fig. S9C).

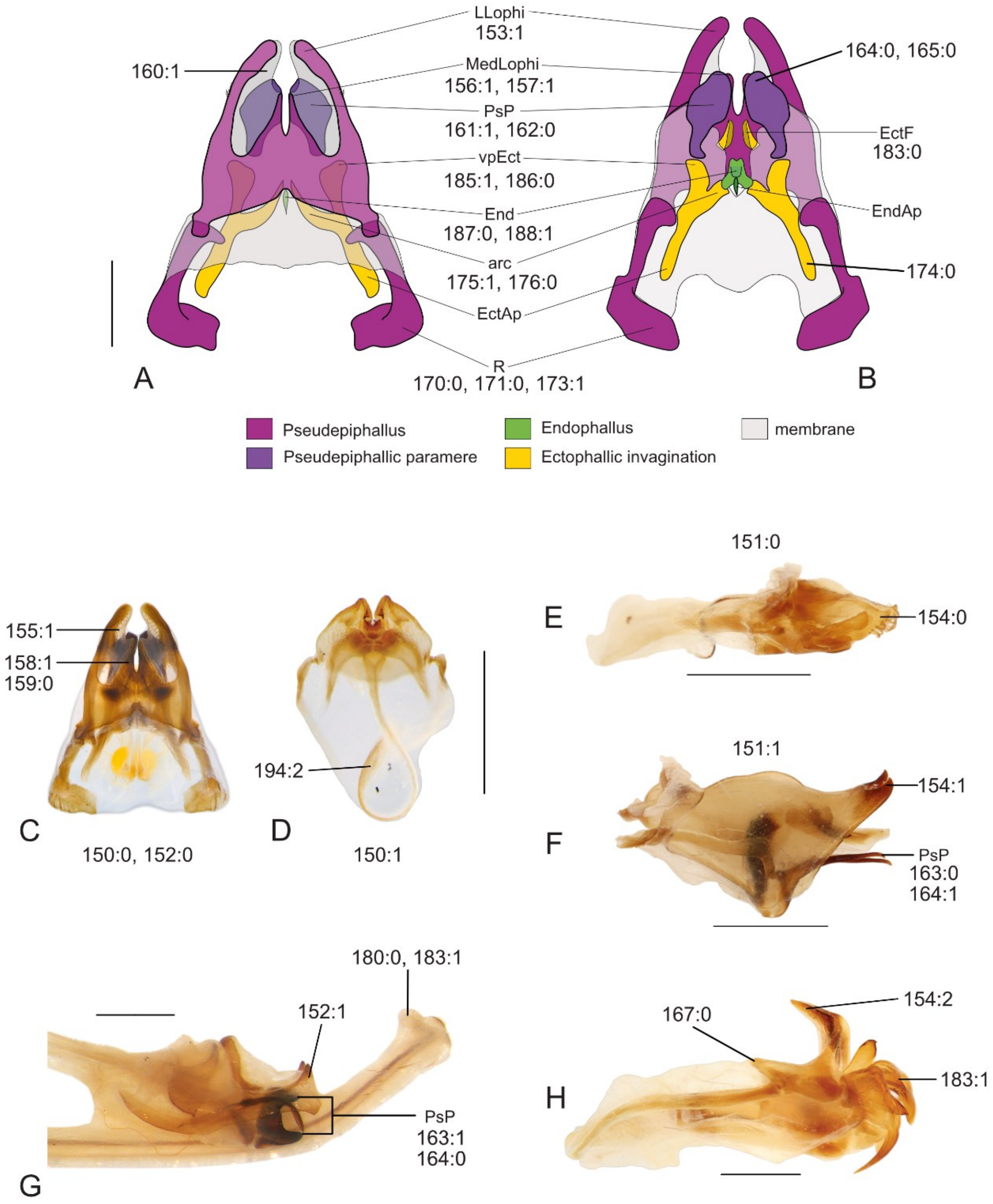


Figure S7. Male genitalia. *Tafalisca vestigialis*: A-dorsal, B-ventral, C-dorsal. D-*Diatrypa* (*Latispeculum*) *aff*. *brunnea*, dorsal; E-*Apterotrypa mitarakensis*, lateral; F-*Fryerius* sp. lateral; G-*Eidmanacris endophallica*, lateral; H-*Aphonomorphus* (*Euaphonus*) sp., lateral. Scales 1 mm. Abbreviations: see material and methods.

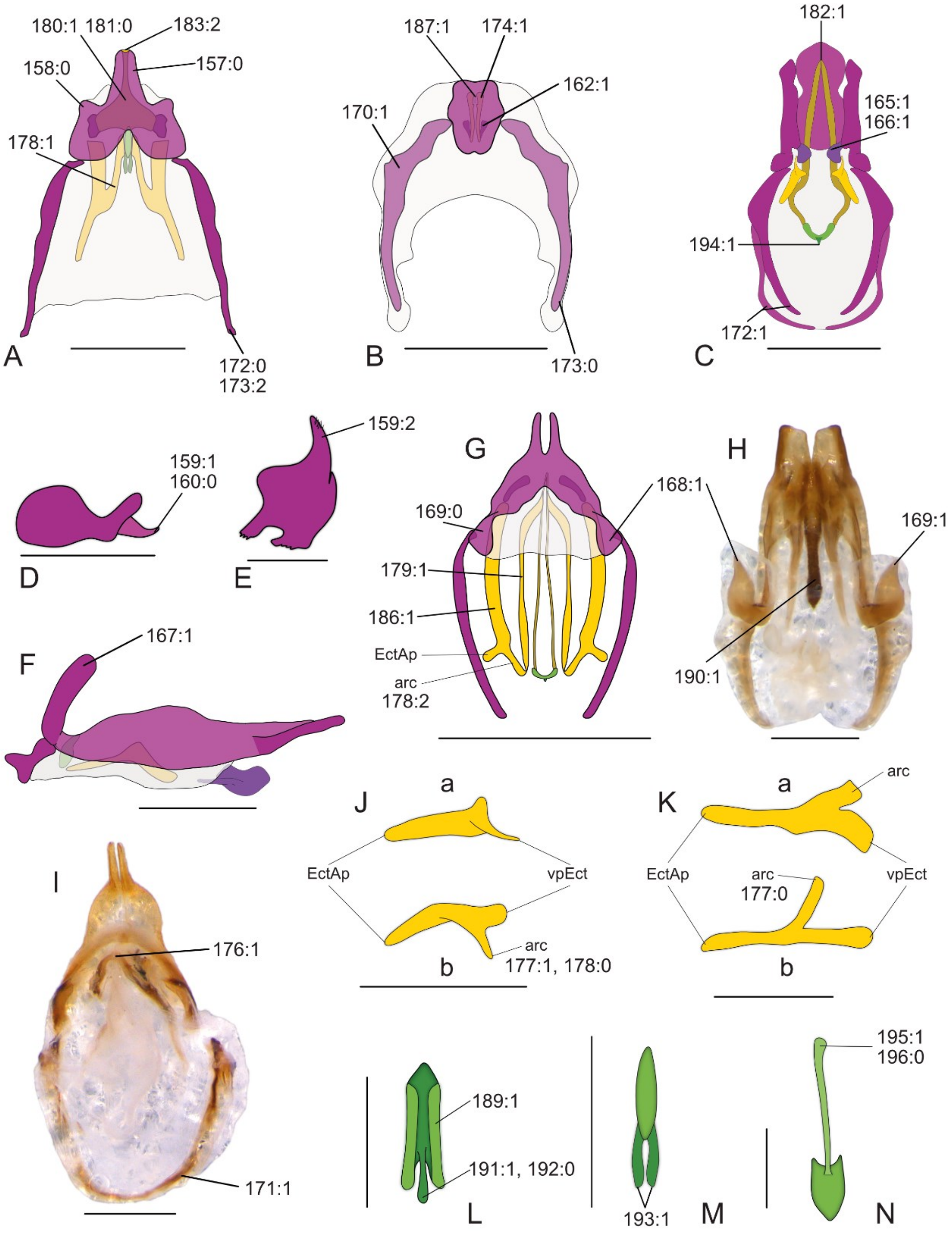


Figure S8. Male genitalia. A-*Veredatrypa fusca*, dorsal; B-*Angustitrella picipes*, dorsal; C-*Stenogryllus* sp., ventral; D-*Hapithus* (*Hapithus*) sp., pseudepiphallic sclerite lateral; E-*Prozvenella bangaloriensis*, pseudepiphallic sclerite lateral; F-*Phyllogryllus velutinus*, lateral; G-*Oecanthus lineolatus*, dorsal; H-*Brazitrypa paulista*, dorsal; I-*Taroba elephantina*, dorsal. Structures from ectophallic invagination, a-ventral, b-lateral: J-*Stenogryllus* sp., K-*Tafalisca vestigialis*. Endophallus: L-*Tafalisca duckeana*, ventral; M-*Veredatrypa fusca*, dorsal; N-*Neometrypus badius*, ventral. Scales A-K 1mm, L-N 0.5 mm. Abbreviations: see material and methods.

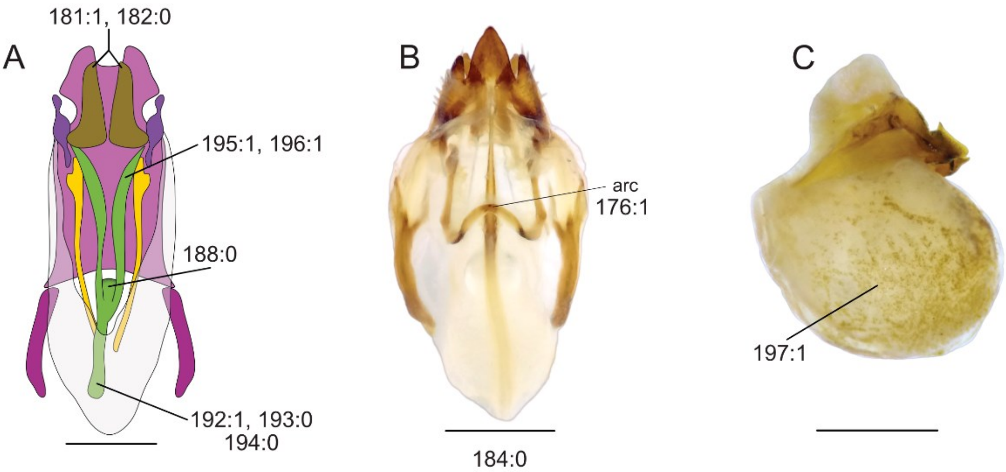


Figure S9. Male genitalia. A-*Eneopteroides bicolor*, ventral; B- *Gryllus* sp. dorsal; C- *Diatrypa* (*Diatrypa*) *tuberculata*, lateral. Scales 1 mm. Abbreviations: see material and methods.

References

Campos, L.D. de, Souza-Dias, P.G.B. de, Desutter-Grandcolas, L., Nihei, S.S. 2021. Colonization of different biomes drove the diversification of the Neotropical *Eidmanacris* crickets (Insecta: Orthoptera: Grylloidea: Phalangopsidae). PLOS ONE. 16, e0245325. doi:10.1371/journal.pone.0245325

Robillard, T., Desutter-Grandcolas, L. 2004. Phylogeny and the modalities of acoustic diversification in extant Eneopterinae (Insecta, Orthoptera, Grylloidea, Eneopteridae). Cladistics. 20, 271–293. doi:10.1111/j.1096-0031.2004.00025.x

Souza-Dias, P.G.B. de. 2015. Análise cladística e morfologia do complexo fálico de Phalangopside, com ênfase em Luzarinae (Orthoptera, Ensifera, Grylloidea) (PhD Thesis). Universidade de São Paulo - Instituto de Biociências, São Paulo.

Appendix 2 – Morphological Matrix

Table S1. Data matrix of morphological data, * indicates the fossils.

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
A. (Aphonomorphus) aff. montanus Jau	1	0	0	1	0	1	1	1	1	0	1	0	-	1	1	0	1	1	1	1	0	1	0	1	0	2	0	1	0	3	1	0	0	0	0	1	1	0	-	-
A. (Euaphonus) sp. GUY	1	0	1	1	0	1	1	1	1	0	1	0	-	1	1	0	0	1	1	1	0	1	0	1	1	2	0	1	0	3	1	0	0	0	0	1	1	0	-	-
Absonemobius guyanensis	1	1	0	1	0	1	1	0	0	0	0	0	-	1	1	2	0	1	0	0	0	0	0	1	1	3	0	0	-	-	-	-	-	-	-	-	-	-	-	?
Adenophallusia legendrei	1	1	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	1	0	1	2	3	1	0	1	0	1	1	1	1	1	1
Adenopterus sp.1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Adenopterus sp.2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Amblyrhethus n.sp.1 Chap.Gui.	1	0	0	1	1	0	0	1	0	0	0	0	-	1	1	2	1	1	1	1	0	0	0	1	0	3	2	1	2	3	1	1	1	0	1	1	1	1	1	1
Amblyrhethus n.sp.2 Linhares	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	2	1	1	1	1	0	0	0	1	0	3	2	1	2	3	1	1	1	0	1	1	1	1	1	1
Amblyrhethus SP. Alagoas	1	0	0	1	0	0	0	1	0	0	0	0	-	1	1	2	1	1	1	1	0	0	0	1	0	3	2	1	2	3	1	1	1	0	1	?	?	?	?	?
Angistitrella vicina 1	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	1	1	1	1	1	1	2	1
Angustitrella aff. vicina 1	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	1	1	?	?	?	?	?	?
Angustitrella mataraku	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	1	1	1	1	1	1	2	1
Angustitrella picipes	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	1	1	1	1	1	1	2	1
Angustitrella sp. GUY	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	1	1	?	?	?	?	?	?
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. Manaus	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	1	1	1	1	1	1	2	1
Angustitrella vicina 2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Anurogryllus sp. Itatiaia	1	1	0	1	0	1	0	0	0	0	0	0	-	1	1	2	1	0	-	0	0	0	0	1	1	1	1	1	1	2	1	0	0	0	1	1	1	1	0	-
Apterotrypa mitarakensis	1	0	0	1	1	0	1	1	0	0	0	0	-	1	1	1	0	1	0	1	0	0	0	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Apterotrypa n.sp.1 Foz	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Apterotrypa n.sp.2 Jau	1	0	0	1	1	1	0	1	0	0	0	0	-	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Apterotrypa n.sp.3 Cariacica	1	0	0	1	1	0	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Apterotrypa n.sp.4 GUY	1	0	0	1	0	0	1	1	0	0	0	0	-	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Aracamby sp. Cantareira	1	0	0	1	1	1	1	1	0	0	0	0	-	1	1	0	0	1	0	1	0	0	0	1	0	1	1	2	-	1	1	0	0	0	0	1	1	1	0	-
Archenopterus adamantus	1	0	1	1	1	1	0	1	0	0	1	0	-	0	1	0	0	1	1	1	0	0	0	1	0	0	2	1	0	3	1	0	1	0	1	1	1	1	0	-
Archenopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Archenopterus sp. NCAL	1	0	1	1	1	1	0	1	0	0	1	0	-	0	1	0	0	1	1	1	0	0	0	1	0	0	2	1	0	3	1	0	1	0	1	1	1	1	0	-
Brazitrypa longiapex	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	1	2	1	2	3	1	0	0	0	0	1	0	0	-	-
Brazitrypa n.sp. Foz	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	1	2	1	2	2	1	0	0	0	?	?	?	?	?	?
Brazitrypa paranaensis	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	2	1	2	2	1	0	0	0	0	1	0	0	-	-
Brazitrypa paulista	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	2	1	2	3	1	0	0	0	0	1	1	0	-	-
Brazitrypa sp. BRA	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	1	2	1	2	3	1	0	0	0	0	1	0	0	-	-
Calscirtus amoa	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	1	3	2	1	0	3	1	0	0	0	1	1	1	1	0	-
Calscirtus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cardiodactylus novaeguineae	1	1	0	1	0	0	1	0	0	0	0	0	-	0	1	2	1	1	1	0	0	0	0	1	0	1	0	1	0	3	1	1	1	0	1	1	1	1	1	0
Cearacesa cearensis	1	0	0	1	0	0	0	1	1	0	1	1	2	1	1	2	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	0	0	0	1	0	0	-	-
Cearacesa nova	1	0	1	1	0	0	0	1	1	0	0	1	2	1	1	2	0	1	1	1	0	0	0	1	0	2	0	1	0	3	1	0	0	0	0	1	0	0	-	-

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Cranistus colliurides	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	2	1	1	0	0	0	0	0	1	1	3	0	1	0	3	1	0	0	0	1	1	1	1	0	-
Creolandreva crepitans	1	1	0	0	-	-	-	-	-	-	0	0	-	1	1	2	1	0	-	0	0	0	0	1	0	1	0	1	0	3	1	0	0	0	1	1	1	1	0	-
Cylindrogryllus pitanga	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	0	1	0	0	0	1	0	1	2	2	-	1	1	0	0	0	0	0	-	-	-	-
Diatrypa (Diatrypa) sp. Sta.Teresa	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	1	3	0	1	0	3	1	1	1	1	1	1	1	1	0	-
Diatrypa (Diatrypa) tuberculata	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	1	3	0	1	0	2	1	1	1	1	1	1	1	1	0	-
Diatrypa (Latispeculum) aff. brunnea	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	1	3	0	1	0	3	1	1	1	1	1	1	1	1	0	-
Diatrypa (Latispeculum) sp. Manaus	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	1	3	0	1	0	3	1	1	1	1	1	1	1	1	0	-
Diatrypini Black n. gen?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eidmanacris endophallica	1	0	0	1	0	0	1	1	0	0	0	0	-	1	1	0	0	1	0	1	0	0	0	1	1	1	1	2	-	0	0	-	-	-	0	0	-	-	-	-
Endecous sp. cantareira	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	0	1	0	0	0	1	1	1	1	2	-	3	1	0	1	0	1	1	1	1	0	-
Eneoptera surinamensis	1	1	0	1	0	1	1	0	0	0	0	0	-	0	1	2	1	0	-	0	0	0	0	1	0	1	0	1	0	3	1	1	1	0	1	1	1	1	1	0
Eumodicogryllus bordigalensis	1	1	0	1	0	0	0	0	0	0	0	0	-	1	1	2	1	0	-	0	0	0	0	1	0	1	1	1	0	2	1	0	0	0	1	1	1	1	0	-
Euscyrtus aff. bipunctatus	0	-	-	1	0	1	-	1	-	-	0	1	1	1	0	0	1	1	1	1	0	0	1	1	1	0	2	2	-	2	1	0	0	0	0	1	0	0	-	-
Euscyrtus bivittatus	0	-	-	1	1	0	-	1	-	-	0	1	1	1	0	0	1	1	1	1	0	0	1	1	1	0	2	1	0	2	1	0	0	0	0	1	0	0	-	-
Fryerius sp. COM	1	0	0	1	1	0	0	1	0	0	0	0	-	1	1	0	1	1	1	1	0	0	0	1	1	1	2	1	0	3	1	0	1	0	1	1	1	1	0	-
Gryllodes sigillatus	1	1	0	1	0	0	0	0	0	0	0	0	-	1	1	2	1	0	-	0	0	0	0	1	0	1	1	1	1	2	1	0	0	0	1	1	1	1	0	-
Gryllophyllus sp. GDP	1	0	0	1	1	0	0	1	1	0	0	0	-	1	1	1	1	1	1	1	0	1	0	1	0	2	0	1	0	3	1	1	1	0	1	1	1	1	1	0
Gryllus sp. Veredas	1	1	0	1	0	1	0	0	0	0	0	0	-	1	1	2	1	0	-	0	0	0	0	1	1	1	1	1	0	2	1	0	0	0	1	1	1	1	0	-
Hapithus sp. MEX	1	0	1	1	0	1	0	1	1	0	0	0	-	1	1	1	1	1	1	1	0	1	0	1	1	2	0	1	1	3	1	0	1	0	1	1	1	1	1	0
Ligypterus linharensis	1	1	0	1	1	1	1	0	0	0	0	0	-	0	1	2	1	1	1	0	0	0	0	1	0	1	0	1	1	2	1	0	1	0	1	1	1	1	1	0
Matuanus aff. mirabilis	1	0	0	1	0	0	0	1	0	0	0	0	-	1	1	0	0	1	1	1	0	0	0	1	0	0	2	1	0	3	1	0	0	0	1	1	1	1	0	-
Mistchenkoana sp. SANTO	1	0	1	1	1	0	1	1	0	0	1	0	-	1	1	0	0	1	1	1	0	0	0	1	1	0	2	1	0	3	1	0	0	0	0	1	0	0	-	?
Munda aff. asyrinx	1	0	0	1	1	1	0	1	0	0	0	0	-	1	1	0	1	1	1	1	0	0	0	1	1	3	2	1	0	3	1	0	0	0	0	1	0	0	-	?
Neometrypus badius	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	0	2	-	0	0	-	-	-	0	0	-	-	-	-
Neometrypus catiae	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	1	0	2	-	0	0	-	-	-	0	0	-	-	-	-
Neometrypus couriae	1	0	0	1	1	0	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Neometrypus marcelae	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	0	2	-	0	0	-	-	-	0	0	-	-	-	-
Neometrypus azevedoi	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	0	2	-	0	0	-	-	-	0	0	-	-	-	-
Neometrypus maiae	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	0	2	-	0	0	-	-	-	0	0	-	-	-	-
Neoxabea brevipes	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	0	-	1	1	0	1	0	1	3	2	1	0	3	1	0	0	0	1	1	1	1	0	-
Neoxabea sp. GUY	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	0	-	1	1	0	1	0	1	3	2	1	0	3	1	0	0	0	?	?	?	?	?	?
Odontogryllus setosus	1	1	0	1	0	0	1	0	0	0	0	0	-	1	1	2	0	0	-	0	0	0	0	1	1	1	1	2	-	0	0	-	-	-	0	0	-	-	-	-
Oecanthus chopardi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus lineolatus	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	0	-	1	0	0	1	0	0	3	2	1	0	3	1	1	1	1	1	1	1	1	0	-
Oecanthus pallidus	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	0	-	1	0	0	1	0	0	3	2	1	0	3	1	1	1	1	1	1	1	1	0	-
Oecanthus sp. BRA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus sp. COM	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	0	-	1	0	0	1	0	0	3	2	1	0	3	1	1	1	1	1	1	1	1	0	-
Perutrella septentrionalis	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	1	0	1	1	1	0	0	0	1	1	0	2	1	0	3	1	0	1	1	1	1	1	1	1	1
Phyllogryllus pipilans	1	0	1	1	0	0	1	1	1	1	0	0	-	1	1	1	1	1	1	1	0	1	0	1	0	2	0	1	0	3	1	1	1	0	1	1	1	1	1	0
Phyllogryllus sp. Veredas	1	0	1	1	0	0	1	1	1	1	0	0	-	1	1	1	1	1	1	1	0	1	0	1	0	2	0	1	0	3	1	1	1	0	?	?	?	?	?	?
Phyllogryllus velutinus	1	0	1	1	0	0	1	1	1	1	0	0	-	1	1	1	1	1	1	1	0	1	0	1	0	2	0	1	0	3	1	1	1	0	1	1	1	1	1	0

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Pixipterus sp. NCAL	1	0	0	1	1	1	0	1	0	0	0	0	-	1	1	0	0	1	1	1	0	0	0	1	1	0	2	1	0	3	1	0	0	0	0	1	0	0	-	-
POD n. gen.? Santo	1	0	1	1	1	0	1	1	0	0	1	0	-	1	1	0	0	1	1	1	0	0	0	1	1	0	2	1	0	3	1	0	0	0	?	?	?	?	?	?
Podo *Archenopterus*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Prognathogryllus pihea	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	0	1	0	-	1	0	0	1	0	1	3	2	1	0	2	1	0	1	-	1	1	1	1	0	-
Proturana subapterus	1	0	0	1	0	0	1	1	0	0	0	1	1	1	0	0	1	1	1	1	0	0	1	1	1	0	2	2	-	1	1	0	0	0	0	0	-	-	-	-
Prozvenella bangalorensis	1	0	1	1	1	1	1	1	0	0	0	0	-	1	1	1	0	1	1	1	0	0	0	1	1	1	0	1	0	3	1	0	1	0	1	1	1	1	0	-
Somnambula livida	1	0	0	1	0	0	0	1	1	0	0	0	-	1	1	1	0	1	1	1	0	1	0	1	0	2	0	1	0	3	1	1	1	0	1	1	1	1	1	0
Somnambula ucayali	1	0	0	1	0	0	0	1	1	0	0	0	-	1	1	2	0	1	1	1	0	1	0	1	1	2	0	1	0	3	1	1	1	0	1	1	1	1	1	0
Sonotrella (Calyptotrella) bispinosa	1	0	0	1	0	0	1	1	1	0	1	0	-	1	1	1	0	1	1	1	0	0	0	1	1	1	1	1	0	3	1	0	1	0	1	1	1	1	0	-
Stenogryllus sp. GDP	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Stenogryllus sp. MGA	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	0	1	1	1	0	1	0	1	0	2	0	1	0	3	1	0	1	0	1	1	1	1	1	0
Tafalisca aff. elongata	1	0	0	1	0	1	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	1	0	3	1	0	0	0	0	1	0	0	-	-
Tafalisca ansoi	1	0	0	0	-	-	-	-	-	-	0	0	-	1	1	0	1	1	1	1	0	0	0	1	1	3	2	1	0	3	1	0	0	0	1	1	0	1	0	-
Tafalisca bahiensis	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	1	2	1	2	3	1	0	0	0	?	?	?	?	?	?
Tafalisca duckeana	1	0	0	1	0	0	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	0	0	3	1	0	0	0	0	1	0	0	-	-
Tafalisca elongata elongata	1	0	0	1	1	1	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	1	0	3	1	0	0	0	0	1	0	0	-	-
Tafalisca hugeli	1	0	0	1	0	0	0	1	0	0	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	3	2	1	0	3	1	0	0	0	1	1	1	1	0	-
Tafalisca n.sp.2 GDP1	1	0	0	1	1	1	0	1	0	0	0	0	-	1	1	0	1	1	1	1	0	0	0	1	0	3	2	1	0	3	1	0	0	0	1	1	1	1	0	-
Tafalisca n.sp.2 GDP2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca sp. Jau	1	0	0	1	1	1	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	1	0	3	1	0	0	0	?	?	?	?	?	?
Tafalisca vestigialis	1	0	0	1	1	0	1	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	1	0	3	1	0	0	0	1	1	1	1	0	-
Taroba elephantina	1	0	0	1	0	0	0	1	1	0	0	1	2	1	1	2	0	1	1	1	0	0	0	1	0	2	0	1	1	1	1	0	0	0	0	1	0	0	-	-
Thaumatogryllus variegatus	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	0	1	0	-	1	0	0	0	0	1	3	0	2	-	0	0	-	-	-	0	0	-	-	-	?
Truljalia hibinonis	1	0	0	1	1	0	1	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	1	3	2	1	0	3	1	0	1	0	1	1	1	1	0	-
Veredatrypa rosai	1	0	0	1	0	0	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	1	2	2	1	0	1	0	1	1	1	1	1	1
Veredatrypa seca	1	0	0	1	0	0	0	1	0	0	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	3	2	1	0	2	1	0	1	0	1	1	1	1	1	1
Xenogryllus eneopteroides	1	1	0	1	0	0	1	0	0	0	0	0	-	0	1	2	1	0	1	0	0	0	0	1	0	1	0	1	0	3	1	1	1	0	1	1	1	1	0	-
Xulavuna n. sp.	1	1	0	1	0	0	1	0	0	0	0	0	-	1	1	2	1	0	-	0	0	0	0	1	0	1	1	2	-	0	0	-	-	-	0	0	-	-	-	-
Zebragryllus nouragui	1	1	0	1	1	1	0	0	0	0	0	0	-	1	1	2	0	0	-	0	0	0	0	1	1	1	1	2	-	3	1	0	1	0	1	1	1	1	0	-
Araneagryllus dylani *	0	-	-	0	-	-	-	-	-	-	0	0	-	1	1	?	?	?	?	1	0	0	0	1	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Araripegryllus camposae *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	1	0	3	1	0	1	0	1	1	1	1	0	-
Birmaninemobius hirsutus *	?	?	?	1	?	?	?	1	?	?	0	0	-	0	1	?	?	1	0	0	0	0	0	1	?	?	0	?	?	2	1	0	0	0	1	1	?	1	0	-
Madassuma europensis *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	?	?	?	?	?	?	?	?	?
Proanaxipha madgesuttonae *	1	1	0	1	0	?	?	1	?	?	0	0	-	1	1	1	1	?	?	0	0	?	?	1	1	1	1	1	0	3	1	0	0	0	1	1	?	1	0	-
Stenogryllodes brevipalpis *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	2	0	1	?	?	?	?	?	?	?	?	?	?	?	?

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
A. (Aphonomorphus) aff. montanus Jau	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	0	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	1	0	1	0	0	1	0	-
A. (Euaphonus) sp. GUY	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	0	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	1	0	1	0	1	1	0	-
Absonemobius guyanensis	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?	-	0	2	-	0	0	-	0	0	0	-
Adenophallusia legendrei	1	1	1	0	1	0	0	0	2	1	1	1	0	0	0	0	0	1	0	1	1	1	0	-	1	0	1	1	1	0	1	1	0	0	1	0	0	0	1	1
Adenopterus sp.1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Adenopterus sp.2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Amblyrhethus n.sp.1 Chap.Gui.	1	1	1	0	1	0	0	0	2	1	1	1	0	0	0	0	0	1	0	1	1	1	0	-	1	1	1	1	1	1	0	1	0	0	1	1	0	0	0	-
Amblyrhethus n.sp.2 Linhares	1	1	1	0	1	0	0	0	2	1	1	1	0	0	0	0	0	1	1	1	1	1	0	-	1	1	1	1	1	1	0	1	0	0	1	0	0	0	1	1
Amblyrhethus SP. Alagoas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	?	?	?	?	?	?
Angistitrella vicina 1	1	1	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	1	0	1	1	1	0	-	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1
Angustitrella aff. vicina 1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	0	?	?	?	?	?	?
Angustitrella mataraku	1	1	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	1	0	1	-	1	0	-	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1
Angustitrella picipes	1	1	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	0	0	1	1	1	0	-	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	0
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	0	?	?	?	?	?	?
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. Manaus	1	1	0	0	1	0	0	1	2	1	1	1	0	0	0	0	0	1	0	1	1	1	0	-	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	0
Angustitrella vicina 2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Anurogryllus sp. Itatiaia	1	1	1	0	1	0	0	0	1	1	1	1	0	0	0	0	0	1	0	1	0	1	0	-	1	0	1	1	1	1	0	1	1	0	0	-	0	0	0	-
Apterotrypa mitarakensis	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	0	?	?	?	?	?	?
Apterotrypa n.sp.1 Foz	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	0	0	0	0	0	0	0	-
Apterotrypa n.sp.2 Jau	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	0	1	0	0	1	1	1
Apterotrypa n.sp.3 Cariacica	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	0	1	0	0	0	1	0
Apterotrypa n.sp.4 GUY	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	0	?	?	?	?	?	?
Aracamby sp. Cantareira	1	1	?	0	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	0	-	-	2	0	-	0	?	?	?	?	?	?
Archenopterus adamantus	0	0	1	0	1	0	0	0	2	0	1	1	1	1	0	1	1	1	0	1	1	0	-	-	-	-	0	1	0	-	0	1	1	0	1	0	0	0	0	-
Archenopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Archenopterus sp. NCAL	0	0	1	0	1	0	0	0	2	0	1	1	1	1	0	1	1	1	0	1	1	1	0	-	2	1	1	1	1	1	0	1	1	1	1	0	0	0	0	-
Brazitrypa longiapex	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	1	1	0	0	1	0	0	0	1	0
Brazitrypa n.sp. Foz	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	0	?	?	?	?	?	?
Brazitrypa paranaensis	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	1	1	0	0	1	0	0	1	1	0
Brazitrypa paulista	-	-	-	0	1	0	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	2	1	0	0	1	0	0	0	1	0
Brazitrypa sp. BRA	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	2	1	0	0	?	?	?	?	?	?
Calscirtus amoa	0	0	1	0	1	0	0	0	2	0	1	1	1	1	0	1	0	1	0	0	-	1	0	-	2	1	1	1	1	0	2	1	0	0	?	?	?	?	?	?
Calscirtus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cardiodactylus novaeguineae	1	1	1	0	1	1	0	0	1	1	1	0	-	-	-	-	0	0	0	1	0	1	1	0	1	0	1	1	1	1	0	1	0	0	1	0	0	0	0	-
Cearacesa cearensis	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	0	1	1	0	1	0	0	-	0	-
Cearacesa nova	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	0	1	1	0	1	0	1	1	0	-
Cranistus colliurides	1	1	?	0	1	0	0	0	0	-	1	0	-	-	-	-	0	0	0	1	0	1	-	-	-	-	1	0	-	-	1	2	-	0	?	?	?	?	?	?
Creolandreva crepitans	1	1	1	0	1	0	0	0	0	-	1	1	0	0	0	0	0	0	0	0	-	1	-	-	-	-	1	1	1	0	0	2	-	0	1	0	0	0	0	-
Cylindrogryllus pitanga	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	-	-	-	-	0	0	-	-	1	2	-	0	1	1	0	0	1	0
Diatrypa (Diatrypa) sp. Sta.Teresa	1	1	1	0	1	0	0	0	2	0	1	1	1	0	0	1	0	1	0	1	1	1	0	-	0	-	1	1	1	1	0	1	0	0	1	1	0	0	1	1

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Diatrypa (Diatrypa) tuberculata	1	1	1	0	1	0	0	0	2	0	1	1	1	0	0	1	0	1	0	1	1	1	0	-	0	-	1	1	1	0	0	1	0	0	1	1	0	0	1	0
Diatrypa (Latispeculum) aff. brunnea	1	1	1	0	1	0	0	0	2	0	1	1	1	0	0	1	0	1	0	1	1	1	0	-	1	1	1	1	1	1	0	1	1	0	1	1	0	0	1	1
Diatrypa (Latispeculum) sp. Manaus	1	1	1	0	1	0	0	0	2	0	1	1	1	0	0	1	0	1	0	1	1	1	0	-	1	1	1	1	1	1	0	1	0	0	?	?	?	?	?	?
Diatrypini Black n. gen?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eidmanacris endophallica	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	?	0	0	-	-	0	0	-	0	0	-	0	0	0	-
Endecous sp. cantareira	1	1	1	0	1	0	0	0	2	0	1	0	-	-	-	-	0	0	0	0	-	1	1	1	1	0	1	0	-	-	0	0	-	0	?	?	?	?	?	?
Eneoptera surinamensis	1	1	1	0	1	0	0	0	1	0	1	1	1	0	1	0	0	1	0	1	1	1	0	-	1	0	1	1	1	1	0	1	1	0	1	0	1	1	1	1
Eumodicogryllus bordigalensis	1	1	1	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	1	1	1	0	2	-	0	?	?	?	?	?	?
Euscyrtus aff. bipunctatus	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	0	-	-	0	1	1	0	?	?	?	?	?	?
Euscyrtus bivittatus	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	0	-	-	0	1	1	0	0	-	?	?	?	?
Fryerius sp. COM	0	0	1	0	1	0	0	0	2	0	1	1	1	1	0	1	0	1	0	0	-	1	0	-	0	-	1	1	1	1	2	1	1	0	?	?	?	?	?	?
Gryllodes sigillatus	1	1	1	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0	1	1	0	1	0	1	0	-	-	0	2	-	0	1	1	0	0	0	-
Gryllophyllus sp. GDP	1	1	0	0	1	0	1	0	2	0	1	1	1	1	0	0	0	1	1	1	1	1	0	-	1	0	1	1	1	1	0	1	1	0	?	?	?	?	?	?
Gryllus sp. Veredas	1	1	1	0	1	0	0	0	2	1	1	1	0	0	0	0	0	1	0	1	0	1	0	-	1	0	1	1	1	0	0	1	1	0	0	-	0	0	0	-
Hapithus sp. MEX	1	1	0	0	1	0	1	0	0	-	0	1	1	1	0	0	0	1	1	1	1	1	0	-	1	0	1	1	1	0	0	1	0	0	?	?	?	?	?	?
Ligypterus linharensis	1	1	1	0	1	1	0	0	0	-	1	0	-	-	-	-	0	0	0	1	0	1	1	0	1	0	1	1	1	0	0	1	1	0	1	0	0	0	0	-
Matuanus aff. mirabilis	0	0	1	0	1	0	0	0	2	0	1	0	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	1	0	?	?	?	?	?	?
Mistchenkoana sp. SANTO	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	2	1	1	0	?	?	?	?	?	?
Munda aff. asyrinx	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	1	0	?	?	?	?	?	?
Neometrypus badius	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	1	2	-	0	1	0	0	0	1	0
Neometrypus catiae	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	1	2	-	0	1	0	0	0	1	0
Neometrypus couriae	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	0	0	0	0	0	0	-
Neometrypus marcelae	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	1	2	-	0	1	1	0	0	1	0
Neometrypus azevedoi	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	1	2	-	0	1	1	0	0	1	0
Neometrypus maiae	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	1	1	0	0	?	?	?	?	?	?
Neoxabea brevipes	1	1	1	0	1	0	0	0	2	0	1	1	1	1	1	0	0	1	0	1	0	1	1	1	1	1	1	0	-	-	1	1	1	0	1	1	1	0	1	0
Neoxabea sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	1	0	?	?	?	?	?	?
Odontogryllus setosus	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	0	-	-	0	2	-	0	0	-	1	1	0	-
Oecanthus chopardi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus lineolatus	1	1	1	0	1	0	0	0	2	0	1	1	1	1	1	0	0	1	0	1	1	1	1	1	0	-	1	0	-	-	1	1	1	0	1	1	1	1	1	1
Oecanthus pallidus	1	1	1	0	1	0	0	0	2	0	1	1	1	1	1	0	0	1	0	1	1	1	1	1	0	-	1	0	-	-	1	1	1	0	1	1	1	1	1	0
Oecanthus sp. BRA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus sp. COM	1	1	1	0	1	0	0	0	2	0	1	1	1	1	1	0	0	1	0	1	1	1	0	-	0	-	1	0	-	-	1	1	1	0	1	1	1	1	?	?
Perutrella septentrionalis	1	1	1	0	1	0	0	1	2	1	1	1	0	0	0	0	0	1	0	1	1	1	0	-	1	1	1	1	1	1	0	1	0	0	1	1	0	1	0	-
Phyllogryllus pipilans	1	1	0	0	1	0	1	0	2	0	0	1	1	1	0	0	0	1	0	1	1	1	0	-	1	0	1	1	1	1	0	1	1	0	1	1	0	0	1	1
Phyllogryllus sp. Veredas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Phyllogryllus velutinus	1	1	0	0	1	0	1	0	1	0	0	1	1	1	0	0	0	1	0	1	1	1	0	-	1	0	1	1	1	1	0	1	1	0	1	1	0	0	0	-
Pixipterus sp. NCAL	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	0	0	?	?	?	?	?	?
POD n. gen.? Santo	?	?	?	?	?	?	?	?	?	?	?	-	?	?	-	-	?	1	0	0	-	?	?	?	?	?	?	?	?	?	0	1	1	0	?	?	?	?	?	?

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Podo *Archenopterus*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Prognathogryllus pihea	1	1	1	0	1	0	0	0	2	0	1	1	1	1	1	0	0	1	0	1	0	1	1	1	1	1	1	0	-	-	1	2	-	0	0	-	1	0	0	-
Proturana subapterus	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	0	0	-	0	?	?	?	?	?	?
Prozvenella bangalorensis	0	0	1	0	1	0	0	0	2	0	1	1	1	1	0	1	0	1	1	1	0	1	0	-	1	1	1	1	1	1	0	1	1	0	1	?	?	?	?	?
Somnambula livida	1	1	0	0	1	0	1	0	2	0	1	1	1	1	0	0	0	1	1	1	1	1	0	-	1	0	1	1	1	1	0	1	1	0	?	?	?	?	?	?
Somnambula ucayali	1	1	0	0	1	0	1	0	2	0	1	1	1	1	0	0	0	1	1	1	1	1	0	-	1	0	1	1	1	1	0	1	1	0	1	1	0	0	0	-
Sonotrella (Calyptotrella) bispinosa	0	0	1	0	1	0	0	0	2	1	1	1	1	1	0	1	0	1	0	1	1	1	0	-	1	1	1	1	1	1	0	1	0	1	?	?	?	?	?	?
Stenogryllus sp. GDP	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Stenogryllus sp. MGA	1	1	0	0	1	0	1	0	0	-	0	1	1	1	0	0	0	1	0	1	1	1	-	-	-	-	1	1	1	1	2	1	0	0	1	0	0	0	1	1
Tafalisca aff. elongata	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	1	1	0	0	1	1	0	0	0	-
Tafalisca ansoi	1	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	0	1	0	0	1	1	0	0	0	-
Tafalisca bahiensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	0	0	?	?	?	?	?	?
Tafalisca duckeana	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	0	0	1	1	0	0	0	-
Tafalisca elongata elongata	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	1	0	-	0	1	0	0	1	1	0	0	0	-
Tafalisca hugeli	1	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	0	0	1	0	0	0	1	1
Tafalisca n.sp.2 GDP1	1	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	0	-	0	-	-	-	-	0	1	0	-	0	1	0	0	1	1	0	0	1	1
Tafalisca n.sp.2 GDP2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca sp. Jau	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	?	?	?	?	?	?
Tafalisca vestigialis	1	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	0	1	0	1	1	0	-	-	-	-	0	1	0	-	0	1	0	0	1	0	0	0	1	1
Taroba elephantina	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	1	0	-	0	-	-	-	-	0	0	-	-	0	1	1	0	1	1	1	0	1	1
Thaumatogryllus variegatus	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	0	0	-	-	1	2	-	0	0	-	0	0	1	1
Truljalia hibinonis	0	0	1	0	1	0	0	0	2	1	1	1	1	1	0	1	0	1	1	1	1	1	0	-	1	1	1	1	1	1	0	1	1	1	?	?	?	?	?	?
Veredatrypa rosai	1	1	1	1	1	0	0	0	2	1	1	1	0	0	1	0	0	1	1	1	1	1	0	-	1	1	1	1	1	0	0	1	0	0	1	1	0	1	1	1
Veredatrypa seca	1	1	1	1	1	0	0	0	2	1	1	1	0	0	1	0	0	1	0	1	1	1	0	-	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	-
Xenogryllus eneopteroides	1	1	1	0	1	0	0	0	1	1	1	0	-	-	-	-	0	1	0	1	1	1	0	-	1	1	1	1	1	1	0	1	0	0	1	0	1	1	0	-
Xulavuna n. sp.	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	-	0	-	-	-	-	0	0	-	-	0	1	1	0	0	-	1	1	1	0
Zebragryllus nouragui	1	1	1	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	-	1	0	1	0	-	-	0	2	-	0	0	-	0	0	0	-
Araneagryllus dylani *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	0	?	?	?	?	?	?
Araripegryllus camposae *	1	1	?	0	1	0	0	0	2	0	1	?	?	?	?	?	0	1	?	1	?	1	1	1	1	0	1	1	1	1	0	?	?	?	?	?	?	?	?	?
Birmaninemobius hirsutus *	1	1	?	0	1	0	0	0	1	0	1	0	-	-	-	-	0	?	?	?	?	1	0	-	0	-	1	0	-	-	2	2	-	0	?	?	?	?	?	?
Madassuma europensis *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	0	?	?	?	?	?	?
Proanaxipha madgesuttonae *	1	1	?	0	1	0	0	0	0	0	1	?	?	?	?	?	0	0	0	?	?	1	-	-	-	-	1	1	1	1	0	1	1	0	?	?	?	?	?	?
Stenogryllodes brevipalpis *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
A. (Aphonomorphus) aff. montanus Jau	0	0	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
A. (Euaphonus) sp. GUY	0	0	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Absonemobius guyanensis	0	1	1	0	1	0	0	2	0	1	0	0	0	1	1	0	0	-	0	0	2	1	0	0	?	-	-	0	0	0	1	1	0	0	1	1	0	0	1	1
Adenophallusia legendrei	0	0	1	1	1	0	0	1	0	2	2	1	0	1	0	0	0	-	1	1	2	1	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	1
Adenopterus sp.1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Adenopterus sp.2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Amblyrhethus n.sp.1 Chap.Gui.	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1
Amblyrhethus n.sp.2 Linhares	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	1
Amblyrhethus SP. Alagoas	?	?	1	?	?	0	0	1	0	1	1	1	0	1	1	0	0	-	1	2	2	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1
Angistitrella vicina 1	0	0	1	0	0	0	0	1	0	2	2	1	0	1	0	0	0	-	0	1	2	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Angustitrella aff. vicina 1	?	?	1	?	?	0	0	1	0	2	2	1	0	1	0	0	0	-	0	1	2	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Angustitrella mataraku	0	0	1	0	0	0	0	1	0	2	2	1	0	1	0	0	0	-	0	1	2	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Angustitrella picipes	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Angustitrella sp. GUY	?	?	1	?	?	0	0	1	0	2	2	1	0	1	0	0	0	-	0	1	2	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. Manaus	0	0	1	0	0	0	0	1	0	2	2	1	0	1	0	0	0	-	0	1	2	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Angustitrella vicina 2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Anurogryllus sp. Itatiaia	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1
Apterotrypa mitarakensis	?	1	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	0	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Apterotrypa n.sp.1 Foz	0	0	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Apterotrypa n.sp.2 Jau	0	1	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Apterotrypa n.sp.3 Cariacica	0	1	1	0	1	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Apterotrypa n.sp.4 GUY	?	?	1	0	?	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Aracamby sp. Cantareira	0	0	1	0	3	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	1	0	0	-	-	-	0	0	0	1	0	1	0	1	1	1	1	1	1
Archenopterus adamantus	0	0	1	0	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Archenopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Archenopterus sp. NCAL	0	0	1	0	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Brazitrypa longiapex	0	0	1	1	0	0	0	1	0	2	0	1	0	1	1	0	0	-	0	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Brazitrypa n.sp. Foz	?	?	1	?	?	0	0	1	0	2	0	0	0	1	1	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Brazitrypa paranaensis	0	0	1	1	0	0	0	1	0	2	0	1	0	1	1	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Brazitrypa paulista	0	0	1	1	0	0	0	1	0	2	0	1	0	1	1	0	0	-	0	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Brazitrypa sp. BRA	?	?	1	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Calscirtus amoa	?	?	1	0	1	1	1	0	0	2	0	0	1	1	0	0	1	1	?	1	0	0	0	1	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
Calscirtus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cardiodactylus novaeguineae	0	0	1	0	0	0	0	2	0	2	2	0	0	1	0	0	0	-	0	1	2	1	0	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Cearacesa cearensis	1	0	1	0	1	0	0	0	0	2	0	0	1	1	0	0	1	1	1	0	2	2	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Cearacesa nova	1	0	1	0	1	0	0	0	0	2	0	0	1	1	0	0	1	1	1	0	2	2	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Cranistus colliurides	?	0	1	0	0	0	0	2	0	1	0	0	0	1	1	0	0	-	0	0	2	1	0	1	?	0	0	1	0	0	1	1	0	0	1	1	0	0	1	1
Creolandreva crepitans	0	0	1	0	1	0	0	0	0	2	0	0	0	1	0	0	0	-	0	0	0	1	0	1	0	0	0	1	0	0	1	1	1	0	1	1	0	0	0	1
Cylindrogryllus pitanga	0	0	1	0	1	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	0	0	1

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Diatrypa (Diatrypa) sp. Sta.Teresa	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	1	1
Diatrypa (Diatrypa) tuberculata	0	0	1	1	0	1	1	0	1	2	3	1	0	0	1	0	1	0	0	3	0	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	1	1
Diatrypa (Latispeculum) aff. brunnea	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	0	1	0	1	1	1	0	1	1
Diatrypa (Latispeculum) sp. Manaus	?	?	1	0	0	1	1	0	1	2	3	1	0	0	1	0	1	0	0	3	0	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	1	1
Diatrypini Black n. gen?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eidmanacris endophallica	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	2	1	0	0	-	-	-	0	0	0	1	0	1	0	1	1	1	0	1	1
Endecous sp. cantareira	0	0	1	0	3	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	1	0	1	0	0	0	0	0	0	1	0	1	0	1	1	1	1	1	1
Eneoptera surinamensis	0	0	1	0	1	0	0	2	0	2	0	0	0	1	0	0	0	-	0	0	2	1	0	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Eumodicogryllus bordigalensis	?	?	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	-	0	0	2	1	0	0	-	-	-	1	0	0	1	1	1	1	1	1	1	1	0	1
Euscyrtus aff. bipunctatus	?	?	1	?	2	0	0	2	0	1	0	0	0	1	0	0	0	-	0	0	2	2	0	0	-	-	-	0	0	0	1	0	1	1	1	1	0	1	1	1
Euscyrtus bivittatus	?	0	1	?	2	0	0	2	0	1	0	0	0	1	0	0	0	-	0	0	2	2	0	1	0	0	0	1	0	0	1	0	1	1	1	1	0	1	1	1
Fryerius sp. COM	?	?	1	0	2	1	1	0	1	2	2	0	1	1	1	1	1	1	0	1	0	0	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
Gryllodes sigillatus	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	-	0	0	2	1	0	0	-	-	-	1	0	0	1	1	1	1	1	1	1	1	0	1
Gryllophyllus sp. GDP	?	?	1	0	3	0	0	0	1	2	0	0	1	1	0	0	1	0	0	0	2	0	0	0	-	-	-	1	0	0	1	1	1	1	1	1	1	0	1	1
Gryllus sp. Veredas	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	-	0	0	2	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	1
Hapithus sp. MEX	?	?	1	?	0	0	0	0	0	2	0	0	1	1	0	0	1	0	1	0	2	1	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1
Ligypterus linharensis	0	0	1	0	1	0	0	2	0	2	0	0	0	1	0	0	0	-	0	0	2	1	0	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Matuanus aff. mirabilis	?	?	1	0	2	1	1	0	1	2	0	0	1	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Mistchenkoana sp. SANTO	?	?	1	0	1	0	1	0	1	2	2	0	1	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1
Munda aff. asyrinx	?	?	1	0	1	0	1	0	?	2	2	0	1	0	1	1	1	1	0	0	1	0	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	1	1
Neometrypus badius	0	0	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Neometrypus catiae	0	0	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	0	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	0	0	1
Neometrypus couriae	0	1	1	0	1	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	0	0	1
Neometrypus marcelae	0	0	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	0	0	1
Neometrypus azevedoi	0	0	1	0	0	0	0	1	0	2	0	1	0	1	0	0	0	-	1	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	0	0	1
Neometrypus maiae	0	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Neoxabea brevipes	0	0	0	0	0	1	0	0	1	2	3	1	0	1	1	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	-	1	0	1	1	0	0	1	0
Neoxabea sp. GUY	?	?	0	0	0	1	0	0	1	2	3	1	0	1	1	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	-	1	0	0	1	0	0	1	0
Odontogryllus setosus	0	0	?	0	1	1	0	0	0	1	0	0	0	1	0	0	0	-	0	0	2	1	0	0	-	-	-	0	0	0	1	1	1	0	1	1	1	1	0	1
Oecanthus chopardi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus lineolatus	0	0	1	0	0	1	0	0	1	2	3	1	0	1	1	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	-	0	0	0	0	0	0	1	1
Oecanthus pallidus	0	0	1	0	0	0	0	0	1	2	3	1	0	1	1	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	-	0	0	0	0	0	0	1	1
Oecanthus sp. BRA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus sp. COM	0	0	1	0	0	0	0	0	1	2	3	1	0	1	0	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	-	0	0	0	0	0	0	1	1
Perutrella septentrionalis	0	0	1	0	1	0	0	1	0	1	2	1	0	1	1	0	0	-	1	2	2	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	1
Phyllogryllus pipilans	0	0	1	0	0	0	0	0	1	2	0	1	1	1	1	0	1	0	0	0	2	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Phyllogryllus sp. Veredas	?	?	1	?	?	0	0	0	1	2	0	0	1	1	1	0	1	0	0	0	2	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Phyllogryllus velutinus	0	0	1	0	0	0	0	0	1	2	0	1	1	1	1	0	1	0	0	0	1	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Pixipterus sp. NCAL	?	?	1	0	2	1	1	0	1	2	0	0	1	1	0	0	1	1	0	1	0	0	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	1	1

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
POD n. gen.? Santo	?	?	1	0	1	0	1	0	1	2	2	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1
Podo *Archenopterus*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Prognathogryllus pihea	0	0	0	0	0	?	?	0	1	2	3	1	0	1	?	0	1	0	0	0	2	0	0	1	0	0	0	1	0	0	0	-	1	0	0	1	0	0	1	0
Proturana subapterus	?	?	1	?	2	0	0	2	0	1	0	0	0	1	0	0	0	-	0	0	2	2	0	0	-	-	-	0	0	0	1	0	1	1	1	1	0	1	1	1
Prozvenella bangalorensis	?	?	1	0	2	1	1	0	1	2	2	0	1	1	1	1	1	1	0	1	0	2	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Somnambula livida	?	?	1	0	0	0	0	0	1	2	0	1	1	1	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Somnambula ucayali	0	0	1	0	0	0	0	0	1	2	0	1	1	1	0	0	1	0	1	0	1	1	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Sonotrella (Calyptotrella) bispinosa	?	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Stenogryllus sp. GDP	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Stenogryllus sp. MGA	0	0	1	0	0	0	0	0	1	2	0	0	1	1	0	0	1	0	1	0	2	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	1	1
Tafalisca aff. elongata	0	0	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	1	0	1
Tafalisca ansoi	0	0	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	1	0	1
Tafalisca bahiensis	?	?	1	?	?	0	0	1	0	2	0	1	0	1	1	0	0	-	0	0	2	1	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Tafalisca duckeana	0	0	1	0	3	0	0	1	0	2	2	1	0	1	1	0	0	-	1	2	0	1	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	0	0	1
Tafalisca elongata elongata	0	0	1	0	3	0	0	1	0	1	1	1	0	1	1	0	0	-	1	2	2	1	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	1	0	1
Tafalisca hugeli	0	0	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	0	0	1
Tafalisca n.sp.2 GDP1	0	0	1	0	3	0	0	1	0	2	1	1	0	1	1	0	0	-	1	2	2	1	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	1	0	1
Tafalisca n.sp.2 GDP2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca sp. Jau	?	?	1	?	?	0	0	1	0	1	1	1	0	1	1	0	0	-	1	2	2	1	0	1	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	1
Tafalisca vestigialis	0	0	1	0	3	0	0	1	0	1	1	1	0	1	1	0	0	-	0	2	0	1	0	0	-	-	-	0	1	0	1	1	1	1	1	1	1	0	0	1
Taroba elephantina	0	0	1	0	1	0	0	0	0	2	0	0	1	1	0	0	1	1	0	0	2	2	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	1	1
Thaumatogryllus variegatus	0	0	0	0	0	?	?	0	1	1	3	0	0	1	0	0	1	0	0	0	2	0	0	0	-	-	-	0	0	0	0	-	1	0	1	1	0	0	1	0
Truljalia hibinonis	?	?	1	0	1	1	1	0	1	2	0	0	1	1	1	0	1	0	0	0	2	2	0	1	0	1	1	1	0	0	1	1	1	0	1	1	1	0	1	1
Veredatrypa rosai	0	0	1	0	0	0	0	1	0	2	1	1	0	1	0	0	0	-	1	2	2	1	0	0	-	-	-	1	0	0	1	1	1	1	1	1	1	1	0	1
Veredatrypa seca	0	0	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	1	0	0	1	1	1	1	1	1	1	1	0	1
Xenogryllus eneopteroides	0	0	1	0	3	0	0	2	0	2	2	0	0	1	0	0	0	-	0	1	2	1	0	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Xulavuna n. sp.	0	0	1	0	3	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	0	0	1	1	1	1	1	1	1	1	0	1
Zebragryllus nouragui	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	-	0	0	2	1	0	0	-	-	-	1	0	0	1	1	1	1	1	1	1	1	0	1
Araneagryllus dylani *	?	?	1	?	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	-	-	-	0	0	0	1	0	1	0	1	1	0	0	1	1
Araripegryllus camposae *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	0	?
Birmaninemobius hirsutus *	?	?	1	?	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	?	?	?	?	?	?	?	1	1
Madassuma europensis *	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	?	?	?	?	?	?	?	?	1	1
Proanaxipha madgesuttonae *	?	?	1	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	0	0	1	0	0	1	?	1	?	1	1	?	?	0	1
Stenogryllodes brevipalpis *	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	0	0	1	?	1	0	1	1	0	0	?	1

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
A. (Aphonomorphus) aff. montanus Jau	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	2	0	0	-	-	-	-
A. (Euaphonus) sp. GUY	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	2	0	0	-	-	-	-
Absonemobius guyanensis	0	0	0	0	0	0	0	0	0	1	0	-	0	0	1	-	-	1	0	1	1	0	0	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Adenophallusia legendrei	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	2	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Adenopterus sp.1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Adenopterus sp.2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Amblyrhethus n.sp.1 Chap.Gui.	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Amblyrhethus n.sp.2 Linhares	1	0	0	0	0	1	0	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Amblyrhethus SP. Alagoas	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Angistitrella vicina 1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Angustitrella aff. vicina 1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Angustitrella mataraku	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Angustitrella picipes	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	2	0	0	-	-	-	-
Angustitrella sp. GUY	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. Manaus	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	2	0	0	-	-	-	-
Angustitrella vicina 2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Anurogryllus sp. Itatiaia	1	1	0	0	0	1	1	1	1	1	0	-	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Apterotrypa mitarakensis	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Apterotrypa n.sp.1 Foz	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Apterotrypa n.sp.2 Jau	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Apterotrypa n.sp.3 Cariacica	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Apterotrypa n.sp.4 GUY	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Aracamby sp. Cantareira	1	0	0	0	0	1	0	0	1	1	1	1	0	1	1	0	2	1	0	1	1	1	1	1	1	1	1	0	0	0	0	1	0	-	-	0	-	-	-	-
Archenopterus adamantus	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	1	0	1	1	0	0	-	-	-	-
Archenopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Archenopterus sp. NCAL	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	1	0	1	1	0	0	-	-	-	-
Brazitrypa longiapex	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Brazitrypa n.sp. Foz	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Brazitrypa paranaensis	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Brazitrypa paulista	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Brazitrypa sp. BRA	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Calscirtus amoa	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	1	0	1	1	0	0	-	-	-	-
Calscirtus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cardiodactylus novaeguineae	1	0	0	0	0	1	0	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Cearacesa cearensis	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	-	-	-	-

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
Cearacesa nova	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	-	-	-	-
Cranistus colliurides	0	0	0	0	0	0	0	0	0	1	0	-	0	0	1	-	-	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	-	-	-	-
Creolandreva crepitans	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	0	2	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Cylindrogryllus pitanga	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	2	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Diatrypa (Diatrypa) sp. Sta.Teresa	1	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	-	-	-	-
Diatrypa (Diatrypa) tuberculata	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	-	-	-	-
Diatrypa (Latispeculum) aff. brunnea	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	-	-	-	-
Diatrypa (Latispeculum) sp. Manaus	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	0	0	0	-	-	-	-
Diatrypini Black n. gen?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eidmanacris endophallica	1	0	0	0	0	1	0	0	1	1	1	1	0	1	1	0	0	1	0	1	1	1	1	1	1	1	1	0	0	0	0	1	0	-	-	0	-	-	-	-
Endecous sp. cantareira	1	0	0	0	0	1	0	0	1	1	1	1	0	1	1	0	2	1	0	1	1	1	1	1	1	1	1	0	0	0	0	1	0	-	-	0	-	-	-	-
Eneoptera surinamensis	1	0	0	0	0	1	0	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Eumodicogryllus bordigalensis	1	1	0	0	0	1	1	0	1	1	0	-	0	1	1	0	2	1	0	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Euscyrtus aff. bipunctatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	0	0	0	-	-	-	-
Euscyrtus bivittatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	1	0	?	?	?	?	?	?	?	?	?	?	?
Fryerius sp. COM	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	0	1	1	1	1	0	0	0	1	0	1	1	0	0	-	-	-	-
Gryllodes sigillatus	1	1	0	0	0	1	1	0	1	1	0	-	0	1	1	0	2	1	0	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	-	-	-	-
Gryllophyllus sp. GDP	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	-	-	-	-
Gryllus sp. Veredas	1	1	1	0	0	1	1	1	1	1	0	-	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Hapithus sp. MEX	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	1	0
Ligypterus linharensis	1	0	0	0	0	1	0	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Matuanus aff. mirabilis	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	0	1	0	1	0	0	0	-	-	-	-
Mistchenkoana sp. SANTO	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Munda aff. asyrinx	1	1	1	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Neometrypus badius	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Neometrypus catiae	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Neometrypus couriae	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Neometrypus marcelae	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Neometrypus azevedoi	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Neometrypus maiae	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	-	-	-	-
Neoxabea brevipes	0	0	0	0	0	0	0	0	-	-	0	-	1	0	0	-	0	1	0	0	0	-	-	0	-	0	-	0	1	0	0	0	1	1	0	0	-	-	-	-
Neoxabea sp. GUY	0	0	0	0	0	0	0	0	-	-	0	-	1	0	0	-	0	1	0	0	0	-	-	0	-	0	-	0	1	?	?	?	?	?	?	?	?	?	?	?
Odontogryllus setosus	1	0	0	0	0	1	0	0	1	1	1	0	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0
Oecanthus chopardi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus lineolatus	1	1	0	0	0	1	1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	-	-	1	1	1	1	0	1	0	0	0	1	0	0	0	-	-	-	-
Oecanthus pallidus	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	0	-	-	1	1	1	1	0	1	0	0	0	1	0	0	0	-	-	-	-
Oecanthus sp. BRA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus sp. COM	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	0	-	-	1	1	1	1	0	1	?	?	?	?	?	?	?	?	?	?	?

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**150**	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**
Perutrella septentrionalis	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	2	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	1	1	1	0	1
Phyllogryllus pipilans	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Phyllogryllus sp. Veredas	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Phyllogryllus velutinus	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	-	0	-	-	-	-
Pixipterus sp. NCAL	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	0	1	0	1	0	0	0	-	-	-	-
POD n. gen.? Santo	1	1	0	0	0	1	0	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Podo *Archenopterus*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Prognathogryllus pihea	0	0	0	0	0	0	0	0	-	-	1	-	1	0	0	-	0	1	1	0	0	-	-	0	-	0	-	0	1	?	?	?	?	?	?	?	?	?	?	?
Proturana subapterus	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	0	1	1	1	1	1	0	1	0	0	1	0	0	0	-	-	-	-
Prozvenella bangalorensis	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	0	0	1	1	0	2	0
Somnambula livida	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Somnambula ucayali	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	-	-	-	-
Sonotrella (Calyptotrella) bispinosa	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	0	0	1	1	0	2	0
Stenogryllus sp. GDP	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Stenogryllus sp. MGA	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	0	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	1	0
Tafalisca aff. elongata	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1
Tafalisca ansoi	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	1	1	1	0	1
Tafalisca bahiensis	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Tafalisca duckeana	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1
Tafalisca elongata elongata	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1
Tafalisca hugeli	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	1	1	1	0	1
Tafalisca n.sp.2 GDP1	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1
Tafalisca n.sp.2 GDP2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca sp. Jau	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Tafalisca vestigialis	1	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	1	1	1	0	1
Taroba elephantina	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	-	-	-	-
Thaumatogryllus variegatus	0	0	0	0	0	0	0	0	-	-	1	-	1	0	0	-	0	1	0	0	0	-	-	0	-	0	-	0	1	0	0	0	1	0	0	0	-	-	-	-
Truljalia hibinonis	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	1	1	0	2	0
Veredatrypa rosai	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	1	0	1	1	0	1	0	0
Veredatrypa seca	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	0	1	1	0	1	0	0
Xenogryllus eneopteroides	1	0	0	0	0	1	0	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	-	-	-	-
Xulavuna n. sp.	1	0	0	0	0	1	0	0	1	1	1	0	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1	1	1	0	0
Zebragryllus nouragui	1	0	0	0	0	1	1	0	1	1	0	-	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	0	0
Araneagryllus dylani *	1	0	0	0	0	1	1	0	1	1	0	-	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	0	0
Araripegryllus camposae *	1	0	0	0	0	1	0	0	?	?	1	1	0	1	1	0	1	1	0	?	?	?	?	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Birmaninemobius hirsutus *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	?	?	?	?	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Madassuma europensis *	0	0	0	0	0	0	0	0	0	1	0	-	0	?	?	?	?	1	?	?	?	?	?	1	1	1	1	?	0	?	?	0	1	0	0	0	-	-	-	-
Proanaxipha madgesuttonae *	1	0	0	0	0	1	0	0	?	1	1	1	1	1	1	0	2	0	1	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?
Stenogryllodes brevipalpis *	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**161**	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**	**180**	**181**	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**	**191**	**192**	**193**	**194**	**195**	**196**	**197**
A. (Aphonomorphus) aff. montanus Jau	1	0	0	0	0	0	0	0	-	1	0	0	1	0	1	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	1	1	0	0	1	1	0
A. (Euaphonus) sp. GUY	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	1	1	0	0	1	1	0
Absonemobius guyanensis	0	-	-	-	-	-	0	0	-	0	0	0	0	0	1	1	-	1	0	0	0	-	0	1	0	-	0	1	0	0	1	0	0	-	1	0	0
Adenophallusia legendrei	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	0	-	0
Adenopterus sp.1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Adenopterus sp.2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Amblyrhethus n.sp.1 Chap.Gui.	1	0	0	0	0	0	0	0	-	1	0	0	0	0	1	0	0	1	0	1	0	-	2	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Amblyrhethus n.sp.2 Linhares	1	0	0	0	0	0	0	0	-	1	0	0	0	0	1	0	0	1	0	1	0	-	2	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Amblyrhethus SP. Alagoas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angistitrella vicina 1	1	1	-	0	0	0	0	0	-	1	0	0	0	1	-	-	-	-	-	0	0	-	0	1	0	-	1	-	-	-	-	-	-	-	-	-	0
Angustitrella aff. vicina 1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella mataraku	1	1	-	0	0	0	0	0	-	1	0	0	0	1	-	-	-	-	-	0	0	-	0	1	0	-	1	-	-	-	-	-	-	-	-	-	0
Angustitrella picipes	1	1	-	0	0	0	0	0	-	1	0	0	0	1	-	-	-	-	-	0	0	-	0	1	0	-	1	-	-	-	-	-	-	-	-	-	0
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Angustitrella sp. Manaus	1	1	-	0	0	0	0	0	-	1	0	0	0	1	-	-	-	-	-	0	0	-	0	1	0	-	1	-	-	-	-	-	-	-	-	-	0
Angustitrella vicina 2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Anurogryllus sp. Itatiaia	1	0	0	0	0	0	0	0	-	0	1	-	-	0	1	1	-	1	0	1	0	-	0	0	1	-	0	1	0	0	1	0	0	1	0	-	?
Apterotrypa mitarakensis	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Apterotrypa n.sp.1 Foz	1	0	1	0	0	0	0	0	-	0	0	0	0	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	1	1	0	0	1	0	-	0
Apterotrypa n.sp.2 Jau	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	1	0	-	-	-	1	0	0
Apterotrypa n.sp.3 Cariacica	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	0	-	0	1	1	1	1	0	0	1	0	-	0
Apterotrypa n.sp.4 GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Aracamby sp. Cantareira	1	0	0	0	0	0	0	0	-	0	0	0	0	0	1	1	-	1	0	0	0	-	0	1	1	0	0	1	0	0	1	0	1	1	0	-	0
Archenopterus adamantus	1	0	0	0	0	0	1	0	-	0	0	0	1	0	0	-	-	-	-	1	0	-	1	1	0	-	0	1	0	0	1	0	0	0	0	-	0
Archenopterus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Archenopterus sp. NCAL	1	0	0	0	0	0	1	0	-	0	0	0	0	0	0	-	-	-	-	1	0	-	1	1	0	-	0	1	0	0	1	1	0	0	0	-	0
Brazitrypa longiapex	1	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	0	1	0	1	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Brazitrypa n.sp. Foz	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Brazitrypa paranaensis	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Brazitrypa paulista	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Brazitrypa sp. BRA	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Calscirtus amoa	1	0	0	0	0	0	1	0	-	0	0	0	0	0	0	-	-	-	-	1	0	-	1	1	0	-	0	0	0	0	1	1	0	0	1	1	0
Calscirtus sp.	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Cardiodactylus novaeguineae	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	1	-	1	0	0	0	-	0	1	1	0	0	1	0	0	1	1	0	0	0	-	0
Cearacesa cearensis	1	0	0	0	0	0	0	0	-	0	1	-	-	0	1	1	0	1	0	1	1	1	0	1	0	-	0	0	0	0	0	-	-	-	0	-	0
Cearacesa nova	1	0	0	0	0	0	0	0	-	0	1	-	-	0	1	1	0	1	0	1	1	1	0	1	0	-	0	0	0	0	0	-	-	-	0	-	0
Cranistus colliurides	0	-	-	-	-	-	0	0	0	0	0	0	0	0	1	1	-	1	0	0	0	-	0	1	0	-	0	1	0	0	0	-	-	-	1	0	0
Creolandreva crepitans	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	1	-	1	0	1	0	-	0	1	1	0	0	1	0	0	0	-	-	-	0	-	0
Cylindrogryllus pitanga	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	1	1	1	0	0	0	-	0

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	**161**	**162**	**163**	**164**	**165**	**166**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**	**180**	**181**	**182**	**183**	**184**	**185**	**186**	**187**	**188**	**189**	**190**	**191**	**192**	**193**	**194**	**195**	**196**	**197**
Diatrypa (Diatrypa) sp. Sta.Teresa	1	0	0	0	0	0	0	0	-	1	0	0	0	0	1	0	1	1	0	1	0	-	0	1	1	0	0	1	1	0	1	0	0	2	0	-	1
Diatrypa (Diatrypa) tuberculata	1	0	0	0	0	0	0	0	-	1	0	0	0	0	1	0	1	1	0	1	0	-	0	1	1	0	0	1	1	0	1	0	0	2	0	-	1
Diatrypa (Latispeculum) aff. brunnea	1	0	0	0	0	0	0	0	-	1	0	0	0	0	1	0	1	1	0	1	0	-	0	1	1	0	0	1	1	0	1	0	0	2	0	-	1
Diatrypa (Latispeculum) sp. Manaus	1	0	0	0	0	0	0	0	-	1	0	0	0	0	1	0	1	1	0	1	0	-	0	1	1	0	0	1	1	0	1	0	0	2	0	-	1
Diatrypini Black n. gen?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eidmanacris endophallica	1	0	1	0	0	0	0	0	-	-	-	-	-	0	1	1	-	1	0	0	0	-	1	1	1	0	0	1	0	0	1	1	0	0	1	0	0
Endecous sp. cantareira	1	0	0	0	0	0	0	0	-	0	0	0	0	0	1	1	-	1	0	0	0	-	0	1	1	1	0	1	0	0	0	-	-	-	1	0	0
Eneoptera surinamensis	1	0	1	0	0	0	0	0	-	0	0	0	1	0	1	1	-	1	0	0	0	-	0	1	1	1	0	1	0	0	1	1	0	0	0	-	0
Eumodicogryllus bordigalensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Euscyrtus aff. bipunctatus	1	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	0	0	-	0	1	0	-	0	1	0	0	0	-	-	-	1	0	0
Euscyrtus bivittatus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Fryerius sp. COM	1	0	0	1	0	0	1	0	-	0	0	0	0	0	0	-	-	-	-	1	0	-	1	1	0	-	0	0	0	0	1	1	0	0	0	-	0
Gryllodes sigillatus	1	0	1	0	0	0	0	0	-	1	0	0	0	0	1	1	-	1	0	1	0	-	0	0	1	-	0	1	0	0	1	0	0	1	0	-	0
Gryllophyllus sp. GDP	1	0	0	0	0	0	1	0	-	0	0	0	1	0	1	0	0	1	0	1	1	1	0	1	1	0	0	0	0	0	1	1	0	0	1	1	0
Gryllus sp. Veredas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Hapithus sp. MEX	1	0	0	0	1	1	0	0	-	0	1	-	-	0	0	-	-	-	-	1	1	1	0	1	0	-	0	0	0	0	1	0	0	1	0	-	0
Ligypterus linharensis	1	0	1	0	0	0	0	0	-	0	0	0	0	0	1	1	-	1	0	0	0	-	0	1	1	1	0	1	0	0	1	1	0	0	0	-	0
Matuanus aff. mirabilis	1	0	1	1	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	0	0	-	1	1	0	-	1	-	0	0	1	1	0	1	1	1	0
Mistchenkoana sp. SANTO	1	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	0	0	-	0	1	0	-	0	1	0	0	1	0	0	1	1	1	0
Munda aff. asyrinx	1	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	0	0	-	0	1	0	-	0	1	0	0	1	1	0	1	1	1	0
Neometrypus badius	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Neometrypus catiae	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Neometrypus couriae	1	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	1	1	0	1	0	-	-	-	1	0	0
Neometrypus marcelae	1	0	1	0	0	0	0	1	1	0	0	1	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Neometrypus azevedoi	1	0	1	0	0	0	0	1	1	0	0	1	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Neometrypus maiae	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	0	1	0	-	-	-	1	0	0
Neoxabea brevipes	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	2	0	1	0	-	0	1	1	1	0	0	0	0	0	-	-	-	1	0	0
Neoxabea sp. GUY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Odontogryllus setosus	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	1	0	-	0	1	1	0	0	1	0	0	0	-	-	-	0	-	0
Oecanthus chopardi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus lineolatus	1	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	2	1	1	0	-	0	1	1	1	0	1	0	0	0	-	-	-	1	0	0
Oecanthus pallidus	1	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	2	1	1	0	-	0	1	1	1	0	1	0	0	0	-	-	-	1	0	0
Oecanthus sp. BRA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Oecanthus sp. COM	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Perutrella septentrionalis	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	0	-	-	-	1	0	0
Phyllogryllus pipilans	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Phyllogryllus sp. Veredas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Phyllogryllus velutinus	1	0	0	0	0	0	1	0	-	0	0	0	1	0	1	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	1	1	0	1	1	1	0
Pixipterus sp. NCAL	1	0	0	1	0	0	1	0	-	0	0	0	0	0	0	-	-	-	-	0	0	-	0	1	0	-	0	1	0	0	0	-	-	-	1	1	0

Table S1. Data matrix of morphological data, * indicates the fossils. Continued.

Taxa	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197
POD n. gen.? Santo	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Podo *Archenopterus*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Prognathogryllus pihea	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Proturana subapterus	1	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	0	0	-	1	1	0	-	0	1	0	0	0	-	-	-	0	-	0
Prozvenella bangalorensis	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	1	1	0	1	1	1	0	0	1	0	0	1	1	0	1	0	-	0
Somnambula livida	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Somnambula ucayali	1	0	0	0	0	0	1	0	-	0	-	0	0	0	1	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	1	1	0	1	1	1	0
Sonotrella (Calyptotrella) bispinosa	1	0	0	1	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	1	1	0	0	1	1	0	1	-	-	-	-	-	-	-	-	-	0
Stenogryllus sp. GDP	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Stenogryllus sp. MGA	1	0	0	0	1	1	0	0	-	0	0	1	3	0	0	-	-	-	-	1	1	1	0	1	1	0	0	0	0	0	1	0	0	1	0	-	0
Tafalisca aff. elongata	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Tafalisca ansoi	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Tafalisca bahiensis	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca duckeana	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Tafalisca elongata elongata	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	1	0	1	1	0	1	0	0	1	0	-	0
Tafalisca hugeli	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Tafalisca n.sp.2 GDP1	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Tafalisca n.sp.2 GDP2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca sp. Jau	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Tafalisca vestigialis	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	0	0	-	0	1	1	0	0	1	1	0	1	0	0	1	0	-	0
Taroba elephantina	1	0	0	0	0	0	0	0	-	0	1	-	-	0	1	1	0	1	0	0	1	1	0	1	0	-	0	0	0	0	0	-	-	-	0	-	0
Thaumatogryllus variegatus	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	-	2	0	1	0	-	0	1	1	1	?	?	?	?	?	?	?	?	?	?	?
Truljalia hibinonis	1	0	0	1	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	1	1	0	1	1	1	0	1	-	-	-	-	-	-	-	-	-	0
Veredatrypa rosai	1	0	0	0	0	0	0	0	-	1	0	0	2	0	1	0	0	1	0	1	0	-	2	1	1	1	0	1	1	0	1	0	1	1	0	-	0
Veredatrypa seca	1	0	0	0	0	0	0	0	-	1	0	0	2	0	1	0	0	1	0	1	0	-	2	1	1	0	0	1	1	0	1	0	1	1	0	-	0
Xenogryllus eneopteroides	1	0	1	0	0	0	0	0	-	0	0	0	1	0	0	-	-	-	-	0	0	-	0	1	0	-	0	1	0	0	1	1	0	0	0	-	0
Xulavuna n. sp.	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0	0	1	0	1	0	-	0	1	1	0	0	1	0	0	0	-	-	-	0	-	0
Zebragryllus nouragui	1	0	1	0	0	0	0	0	-	1	0	0	3	0	1	1	-	1	0	1	0	-	0	0	1	-	0	1	0	0	1	0	0	1	0	-	0
Araneagryllus dylani *	1	0	1	0	0	0	0	0	-	1	0	0	3	0	1	1	-	1	0	1	0	-	0	0	1	-	0	1	0	0	1	0	0	1	0	-	0
Araripegryllus camposae *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Birmaninemobius hirsutus *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Madassuma europensis *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Proanaxipha madgesuttonae *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Stenogryllodes brevipalpis *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

Supporting figures

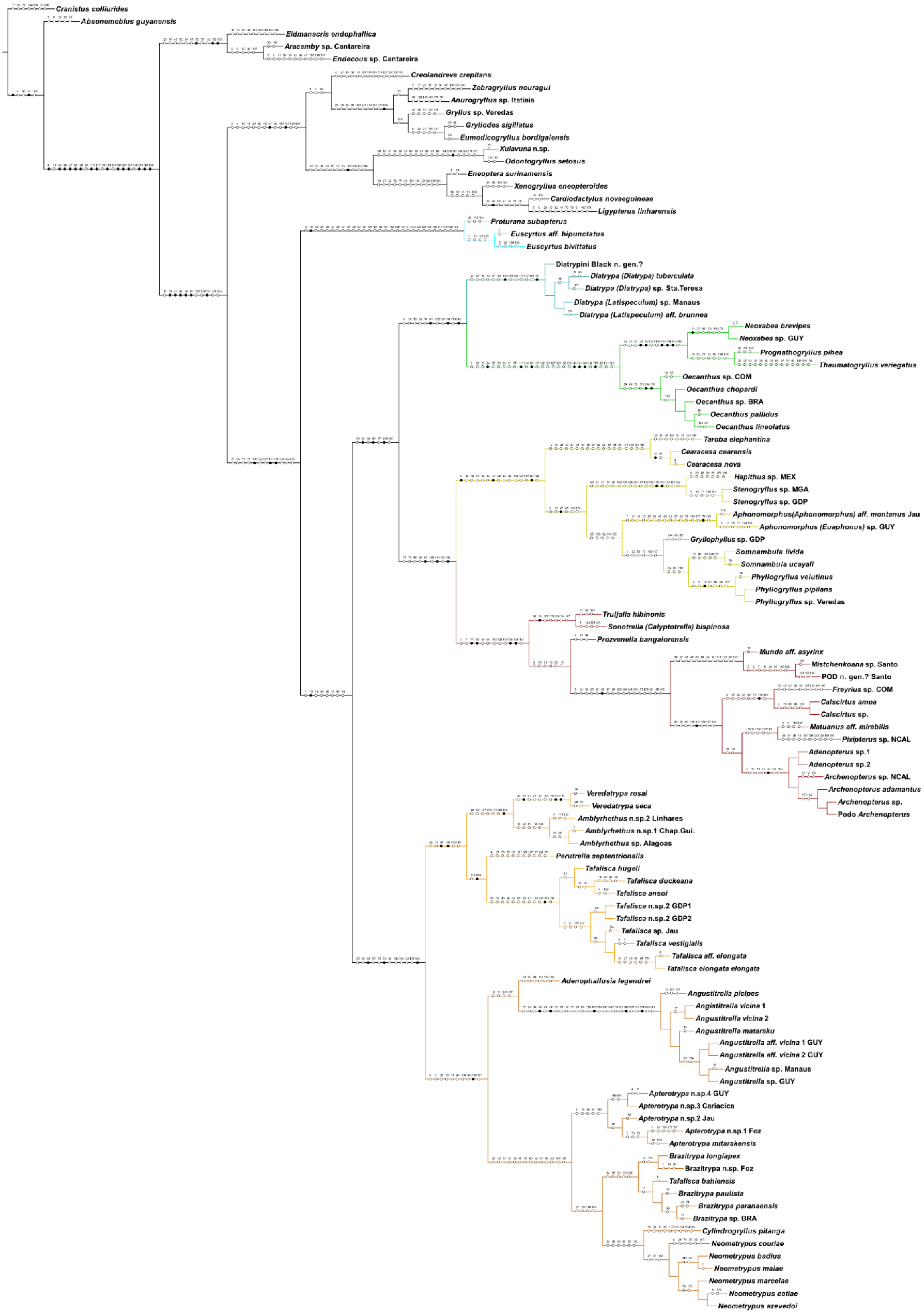


Figure S10. Strict consensus tree of Oecanthidae n. status of four most parsimonious trees based on 107 terminals, four molecular markers, and 197 morphological characters (13,684 steps; ci 0.23; ri 0.59) under equal weights, and characters optimized. White circles indicate homoplastic synapomorphies, black circles exclusive synapomorphies. Number above circle indicates the characters, above the states.

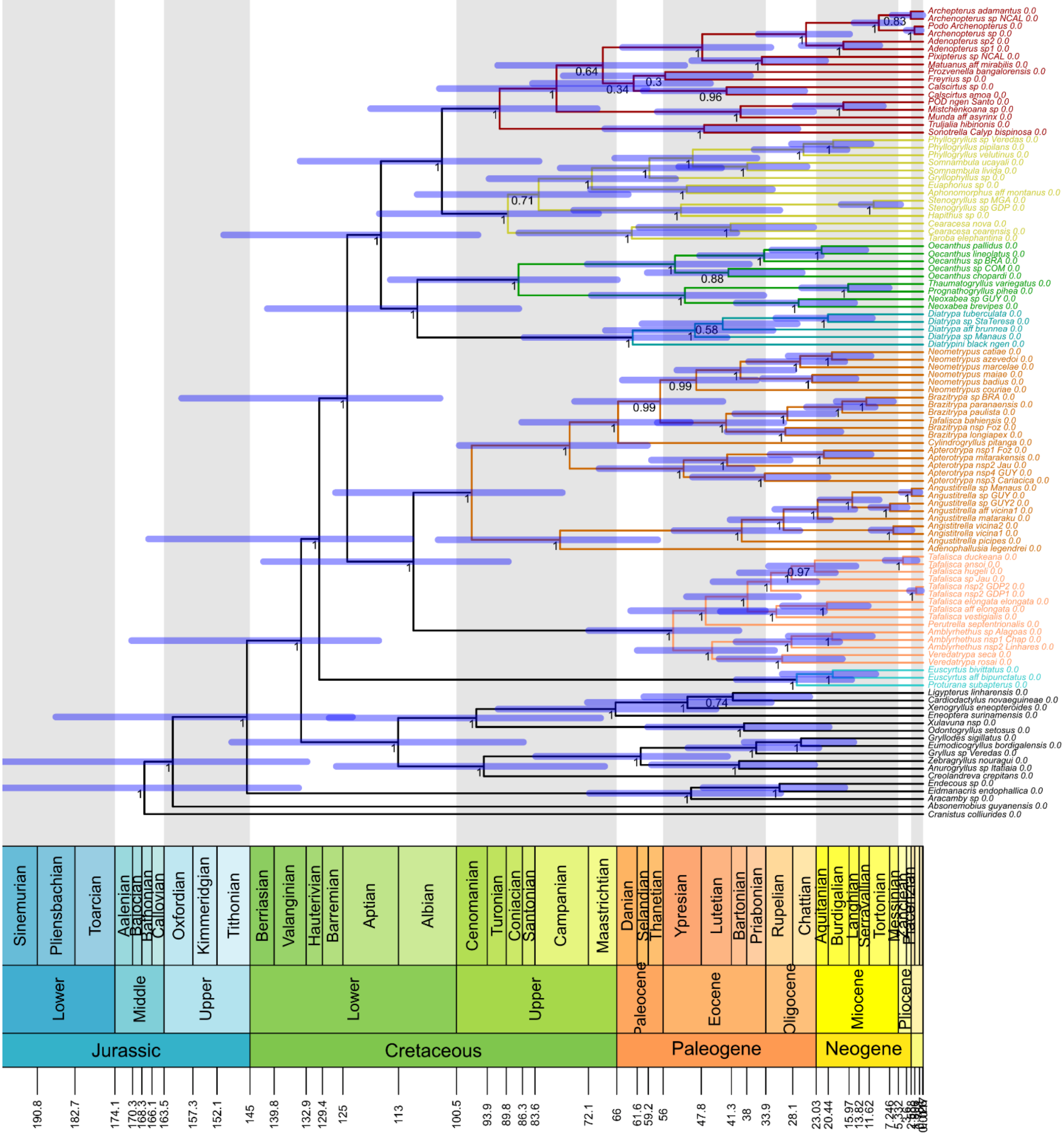


Figure S11. Time-calibrated phylogenetic tree of Oecanthidae n. status. Divergence time analysis under Bayesian inference based on four DNA markers and six fossil calibrating internal nodes. Bars indicate 95% highest posterior density intervals for all nodes. Posterior probabilities are indicated in black numbers.

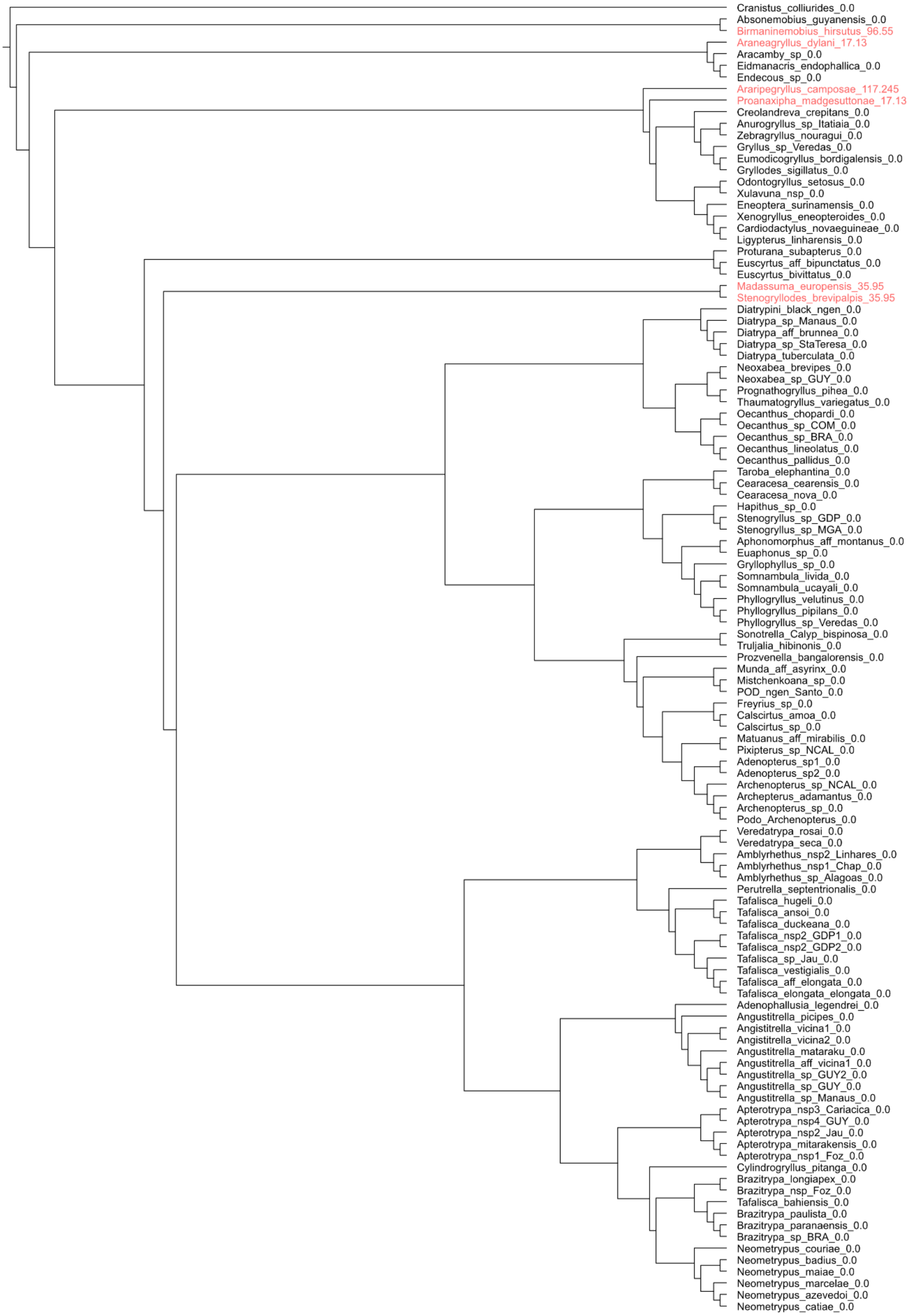


Figure S12. Summarized phylogenetic tree of Oecanthidae n. status based on molecular and morphological characters obtained under Bayesian Inference. Red taxa indicate included fossils placement.

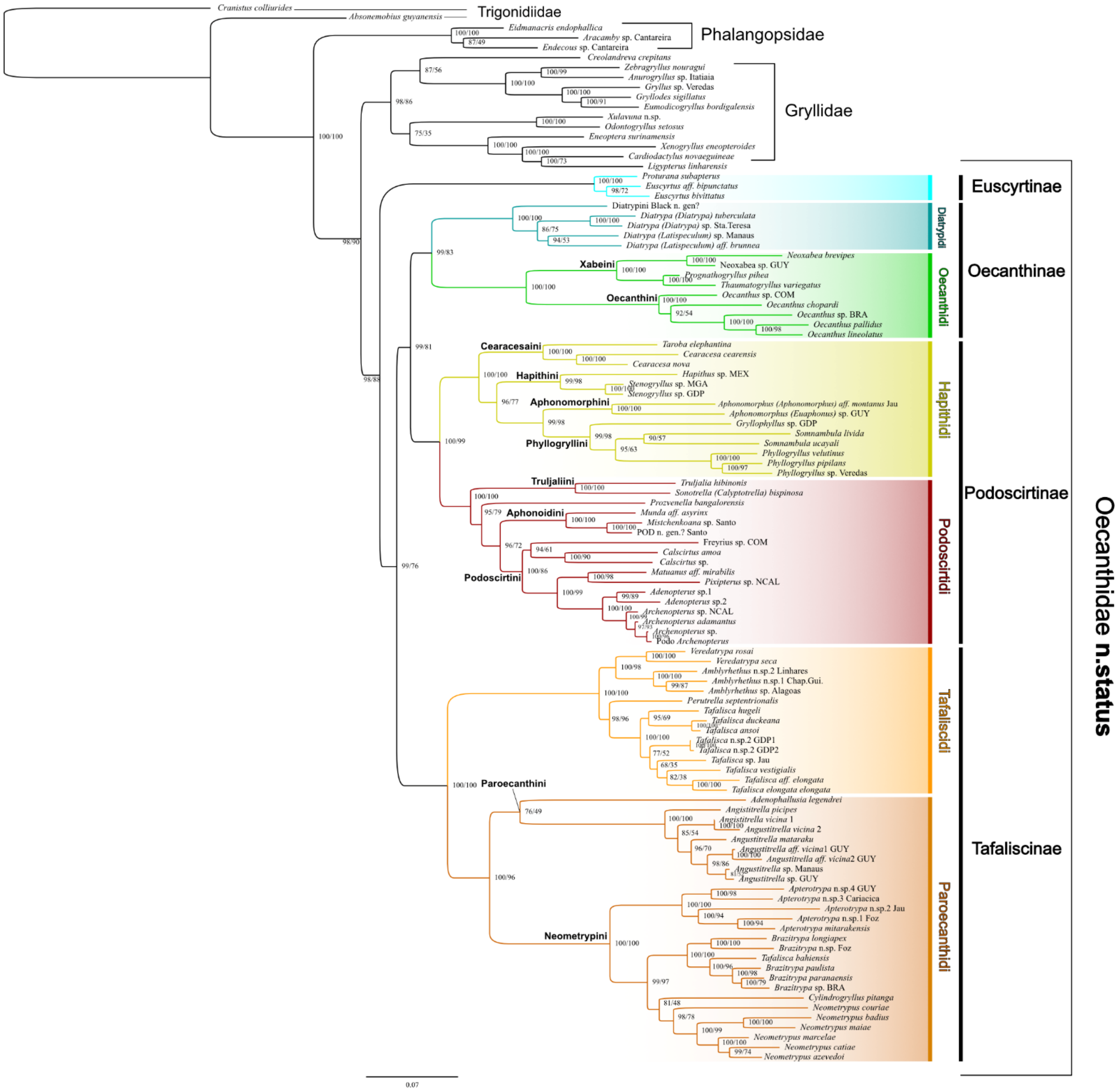


Figure S13. Phylogeny under maximum likelihood criteria of Oecanthidae n. status based on 107 terminals, four molecular markers, and 197 morphological characters. Support values (Ultrafast bootstrap/Bootstrap) are indicated in the nodes.

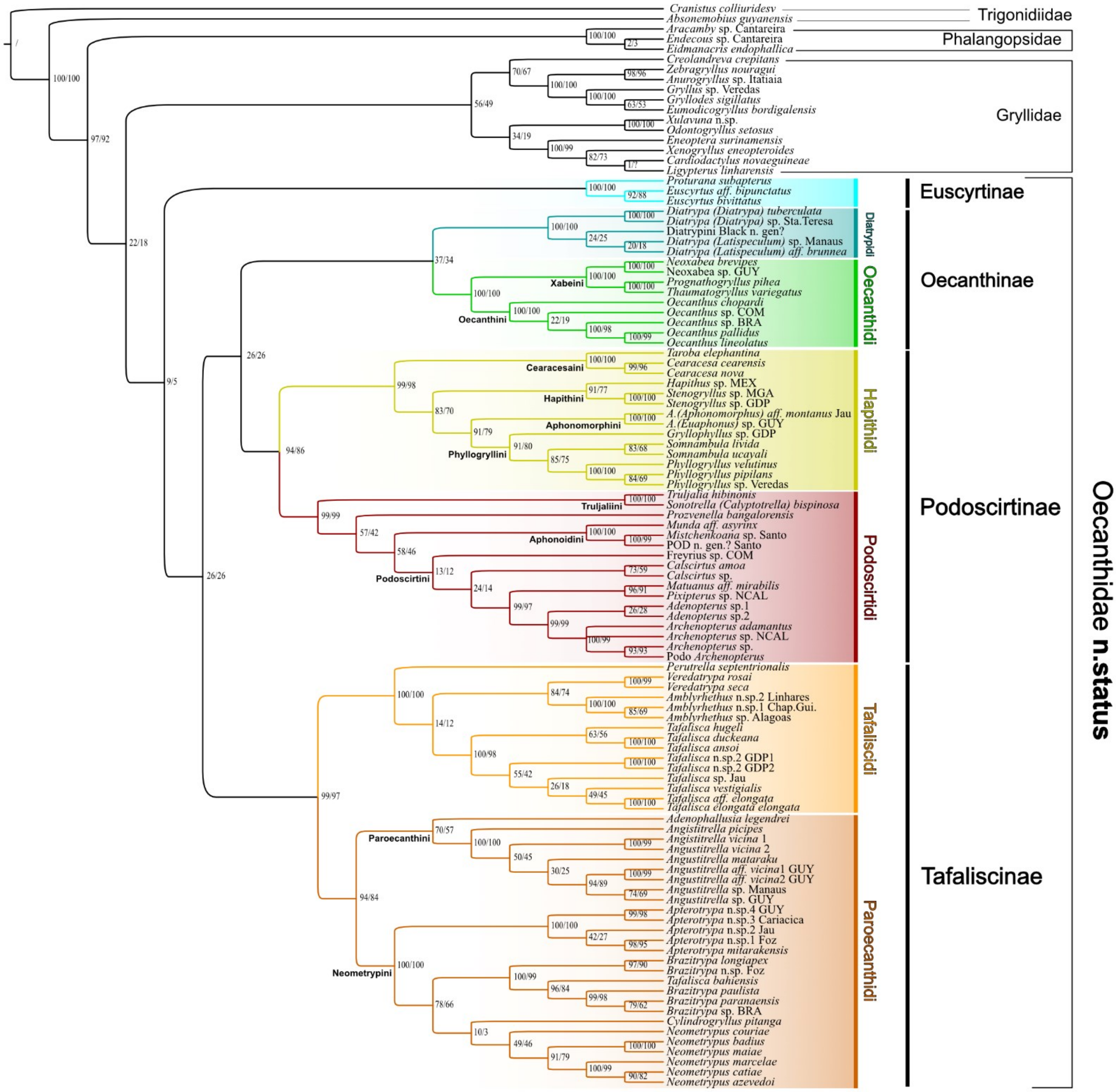


Figure S14. Strict consensus tree of Oecanthidae n. status of four most parsimonious trees based on 107 terminals, four molecular markers, and 197 morphological characters (13,684 steps; ci 0.23; ri 0.59) under equal rates. Support values (Jackknife/Bootstrap) are indicated in the nodes.

Appendix 3 – Diagnoses

Family OECANTHIDAE Blanchard, 1845 n. status

Oecanthites Blanchard, 1845: 245. Saussure, 1874: 428. Saussure, 1878: 590
Oecanthiens Saussure, 1874: 427. Saussure, 1878: 534.
Oecanthinae Saussure, 1897: 251. Scudder, 1987: 62. Azam, 1901: 104. Kirby, 1906: 109. Zeuner, 1939: 212. Walker, 1966: 265. Otte & Alexander, 1983: 374. Gorochov, 1986: 851-858. Toms & Otte, 1988: 471. Nickle, 1992: 195. Otte, 1994: 85. Rentz, 1996: 147. Otte & Perez-Gelabert, 2009: 491. Gorochov, 2015: 31-34. Collins & Carson, 2014: 170. Chintauan-Marquier, et al. 2016: 73. Rentz & Su, 2019: 231.
Oecanthidae Brunner von Wattenwyl, 1873: 164. Brunner von Wattenwyl, 1882: 420. Bruner, 1916: 395. Chopard, 1949: 673. Chopard, 1951: 198. Vickery, 1977: 11. Chopard, 1968: 427. Kevan, 1982: 2. Desutter, 1987: 223. Coray & Lehmann, 1998: 94.

Type genus. *Oecanthus* Serville, 1831.
Distribution. Worldwide.
Diagnosis. Crickets inhabiting trees and shrubs (a few exceptions registered in caves, see Xabeini), small to large size; apterous, brachypterous, or with developed wings (with or without stridulatory apparatus). Latero-anterior regions of metanotum generally inflated (Fig. S4C, D, E), sometimes with bristles. TIII with five or more inner apical spurs (except Oecanthidi); 1st and 2nd tarsomeres of legs I and II same-sized with pulvillum (Fig. S5J, L) and 2nd tarsomere of leg III with pulvillum, 2nd tarsomere of TI and TII flattened dorso-ventrally (except some Oecanthidi); inner apical spurs three times or more longer than outer apical spurs of TIII (Fig. S6D); apex of ovipositor generally with projections, protuberances and/or lateral margins serrulated, sometimes smooth (Euscyrtinae) (Fig. S15D), ovipositor generally upcurved, sometimes straight or downcurved. Male genitalia: median region of ectophallic arc not connected (Fig. S7A) (except Cearacesaini).

Included subfamilies:

- Euscyrtinae Gorochov, 1985
- Oecanthinae Blanchard, 1845

-Podoscirtinae Saussure, 1878
-Tafaliscinae Desutter, 1988

The family Oecanthidae is composed majority of crickets that live in plants, from long grasses to tall trees. The apex of their ovipositor, generally strongly sclerotized, bears serrulation and/or structures adapted to ovipositing inside leaves and under the bark of trees. Their forewings are very diverse, and several groups are characterized by their acoustic apparatus or non-acoustic communication structures. This newly erected family was considered as the Clade F in Chintauan-Marquier *et al.* (2016) and as the Podoscirtinae Subfamily Group by Cigliano *et al.* (2022). Both classifications considered this group inside of Gryllidae. Based on the phylogenetic hypotheses presented above with solid support, this lineage is formally elevated to a valid taxonomic category (Figs. 2, S13, S14).

Subfamily EUSCYRTINAE Gorochov, 1985

Euscyrtinae Gorochov, 1985: 89. Gorochov, 1986: 138. Gorochov, 1987: 1-192. Desutter, 1987: 234. Otte, 1994: 70. Yin & Liu, 1995: 116; Yang & Yang, 2012: 1-45. Gorochov, 2015: 31-41. Chintauan-Marquier, et al. 2016: 73. Rentz & Su, 2019: 192. Meena & Swaminathan, 2020: 559.

Type genus. *Euscyrtus* Guérin-Méneville, 1844.
Distribution. Tropical regions, except South America.
Diagnosis. Mainly found in shrubs and tall grasses, from small to medium size. Top of fastigium truncated in frontal and lateral views (Figs S1G, S15B). TIII with six or more inner subapical spurs; claws inner margin serrulated (Figs S6Gb, S15C), more or less as in Trigonidiinae (Trigonidiidae). FWs present or absent, when present generally without stridulatory apparatus. Ovipositor generally downcurved in lateral view; apex of dorsal valves above ventral apex of ventral valves; apex not enlarged; lateral margins of apex smooth (Fig. S15D).

Included genera:
-*Beybienkoana* Gorochov, 1988
-*Burrianus* Chopard, 1962
-*Euscyrtodes* Gorochov, 1987

-*Euscyrtus* Guérin-Méneville, 1844
-*Merrinella* Otte & Alexander, 1983
-*Patiscodes* Gorochov, 1988
-*Patiscus* Stål, 1877
-*Proturana* Otte, 1987
-*Tozeria* Otte & Alexander, 1983
-*Turana* Otte & Alexander, 1983

Remark. There are no records of these crickets in South America until now. However, some representatives (not yet described) with all features of Euscyrtinae were observed in the MNHN collection registered from South America (LDC pers. obs.).

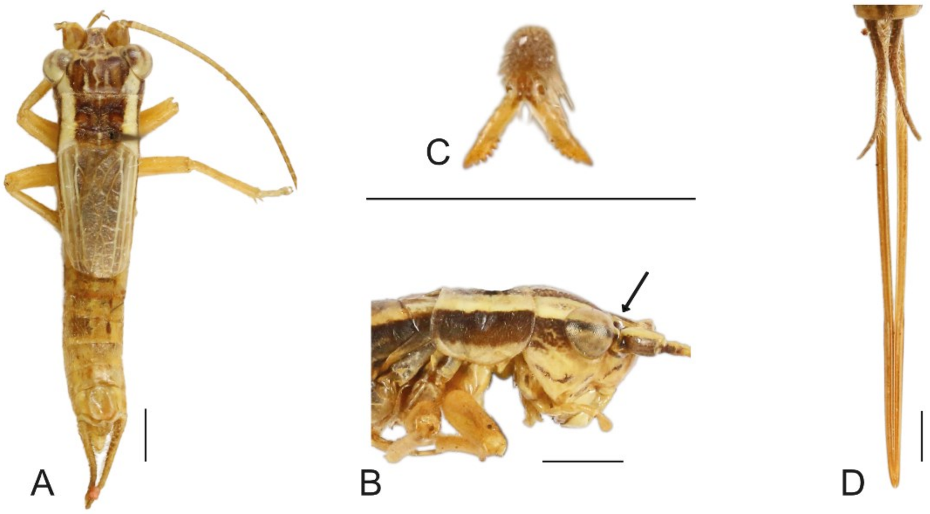


Figure S15. A-*Euscyrtus aff. bipunctatus*, male, dorsal habitus. *Proturana subapterus*: B-head and pronotum, lateral view; C-claw; D-ovipositor; dorsal view. Scales: 1mm.

Subfamily OECANTHINAE Blanchard, 1845

Oecanthites Blanchard, 1845: 245. Saussure, 1874: 428. Saussure, 1878: 590
Oecanthiens Saussure, 1874: 427. Saussure, 1878: 534.
Oecanthinae Saussure, 1897: 251. Scudder, 1987: 62. Azam, 1901: 104. Kirby, 1906: 109. Zeuner, 1939: 212. Walker, 1966: 265. Otte & Alexander, 1983: 374. Gorochov 1986: 851-858. Toms & Otte, 1988: 471. Nickle, 1992: 195. Otte, 1994: 85. Rentz, 1996: 147. Otte & Perez-Gelabert, 2009: 491. Gorochov, 2015: 31-34. Collins & Carson, 2014: 170. Chintauan-Marquier, et al. 2016: 73. Rentz & Su 2019: 231.

Type genus. *Oecanthus* Serville, 1831.
Distribution. Worldwide.
Diagnosis. Generally found in trees or bushes. Almost all representatives with well-developed FWs and stridulatory apparatus; lateral field not perpendicular to dorsal field, forming less than 90° angle (easily observable in posterior view) (Fig. S2J2). TIII iav spur significantly reduced (Fig. S6E). Dorsal valves of ovipositor bifurcate (Figs. S4Ja; S5C, D), covering ventral valves laterally. Male genitalia: pseudepiphallic sclerite wider than long; LLophi bilobate.

Included supertribes:
- -Oecanthidi Blanchard, 1845 n. status
- -Diatrypidi Desutter, 1988 n. status
- -Incertae sedis: *Stenoecanthus* Chopard, 1912

Supertribe Oecanthidi Blanchard, 1845 n. status

Oecanthites Blanchard, 1845: 245. Saussure, 1874: 428. Saussure, 1878: 590

Type genus. *Oecanthus* Serville, 1831.
Distribution. Worldwide.
Diagnosis. Small to medium and generally slender crickets; head prognathous; pronotum longer than wide, caudal margin wider than cephalic margin in dorsal view; FWs generally hyaline; when present, mirror well-developed, generally divided by two straight and parallel veins (Figs S3H, S16B,); apical field generally absent or sometimes shorter than mirror; auditory tympana oval and large present on inner and outer face of TI; inner ventral apical spur of TI and TII absent; FIII thin, proximal portion with similar width of distal portion in lateral view; dorsal spines of tarsomere of leg III absent (Fig. S17A); claws bifid (Figs S6G, S16C). Male genitalia: ectophallic arc curved anteriorly; ectophallic apodeme generally short (Fig. S8G).

Included tribes:
- -Oecanthini Blanchard, 1845
- -Xabeini Vickery & Kevan, 1983

-Incertae sedis: *Paraphasius* Chopard, 1927

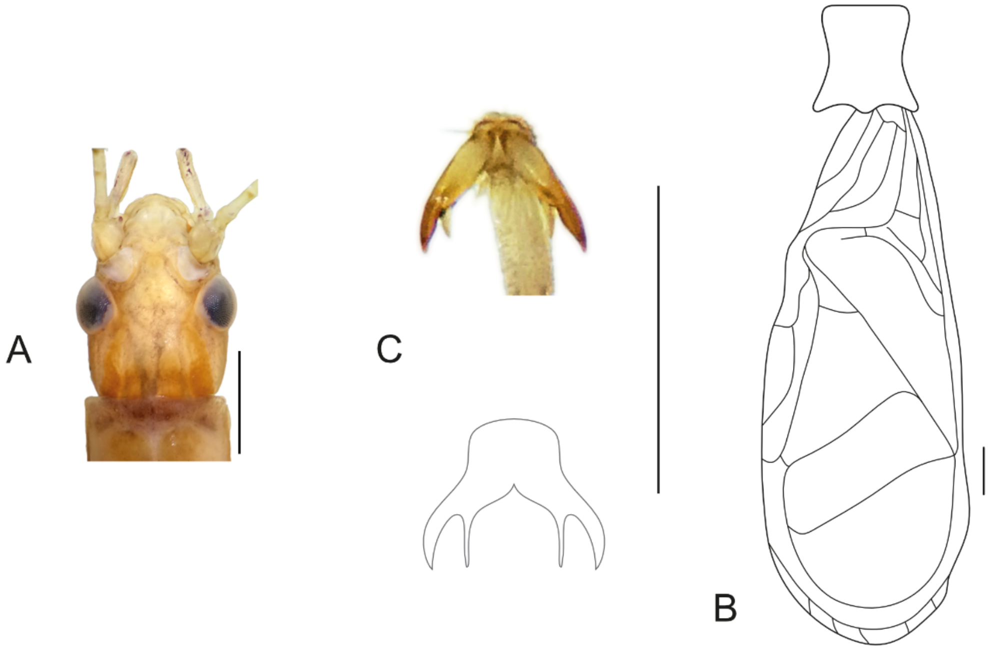


Figure S16. A-*Neoxabea brevipes*, head dorsal view. *Oecanthus* sp.: B-male, pronotum and right FW; C-claw. Scales: 1mm.

Tribe Oecanthini Blanchard, 1845

Oecanthites Blanchard, 1845: 245. Saussure, 1874: 428. Saussure, 1878: 590

Oecanthini Otte, 1994: 85. Rentz & Su, 2019: 232.

Type genus. *Oecanthus* Serville, 1831.

Distribution. Worldwide.

Diagnosis. Frequently green or pale brown, however, with representatives with other colors. 5th article of maxillary palpus straight; male metanotum generally with a central fossa and a central cluster of bristles. Outer ventral spur of TII absent; TIII generally with 3/3 subapical spurs. Male genitalia: distal projection of ectophallic arc present (Fig. S8G).

Included genera:

- *Oecanthodes* Toms & Otte, 1988
- *Oecanthus* Serville, 1831
- *Viphyus* Otte, 1988

Tribe Xabeini Vickery & Kevan, 1983

Xabeinae Vickery & Kevan, 1983:649.

Xabeini Otte, 1994: 87. Gorochov, 1995: 45. Rentz & Su, 2019: 235.

Type genus. *Xabea* Walker, 1869.

Distribution. Australasia, Indo-Malay, Nearctic, Neotropic, and Oceania.

Diagnosis. Antennal scape sometimes with a distal tubercle (Fig. S16A); FWs generally developed, except for *Leptogryllus* and *Thaumatogryllus* that are brachypterous or apterous (endemic of Hawaiian Islands). Cerci shorter than FII (Fig. S4G); TIII subapical spurs absent (Fig. S17A); TIII oav and iav absent; spines, inner and outer apical spurs of tarsomere I of leg III absent (Fig. S17B, C).

Included genera:

- genus group *Prognathogryllus* Zimmerman, 1948
    - *Leptogryllus* Perkins, 1899
    - *Prognathogryllus* Brunner von Wattenwyl, 1895
    - *Thaumatogryllus* Perkins, 1899
- genus group *Xabea* Vickery & Kevan, 1983
    - *Neoxabea* Kirby, 1906
    - *Xabea* Walker, 1869

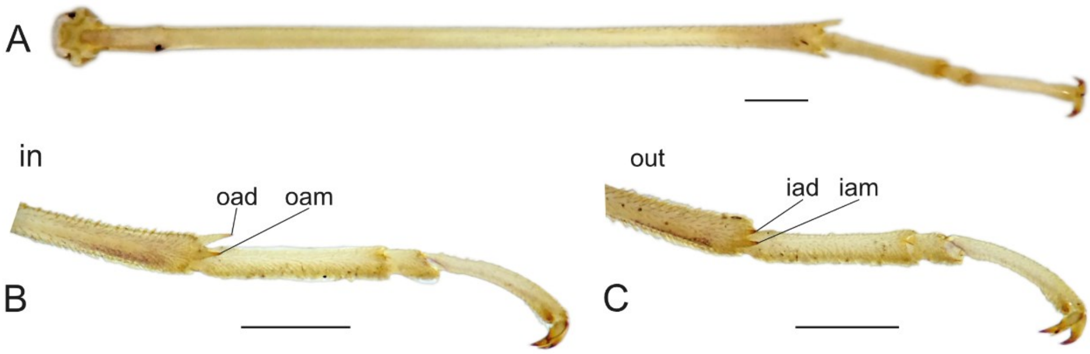


Figure S17. *Neoxabea breviepes*. A-hind tibia and tarsi; B-hind tibia distal margin and tarsi, inner view; C-hind tibia distal margin and tarsi, outer view. Scales: 1mm. Abbreviations: see material and methods.

Supertribe Diatrypidi Desutter, 1988 n. status

Diatrypini Desutter, 1987:235. Desutter, 1988: 369. Otte, 1994: 65. Gorochov, 1995: 1-213.
Diatrypina Gorochov, 2013: 16. Gorochov, 2017: 98.

Type genus. *Diatrypa* Saussure, 1874.
Distribution. Neotropic.
Diagnosis. Small-sized with developed HWs, FWs, and stridulatory apparatus (Fig. S18A, B). FWs apical field present, generally smaller or with same size of mirror; TI auditory tympana present on inner and outer faces; TIII subapical spurs 5/5. Female subgenital plate posterior border surrounding ovipositor (Fig. S4J). Ventral valves of ovipositor bifurcate; apex of ovipositor wider than the structure in dorsal and ventral views (Figs. S4J; S5C, D). Male genitalia: dorsal valves well-developed; endophallic sclerite elongate, two or more times longer than pseudepiphallic sclerite (Fig. S7D); spermatophore generally well-developed and well sclerotized.

Included genus:
-*Diatrypa* Saussure, 1874

Remark. Previously considered a subtribe of Aphonoidini (Podoscirtinae) (Cigliano *et al.*, 2022), this lineage is elevated to supertribe and is transferred to Oecanthinae based on the phylogenetic hypotheses presented here. This clade includes only one genus divided into two subgenera with 67 species. The genus *Diatrypa* must be reviewed, as many new taxa (specimens observed in MNHN and MZSP) are to be described. This group is presently a very poorly documented group, perhaps because it occurs mostly in the canopy.

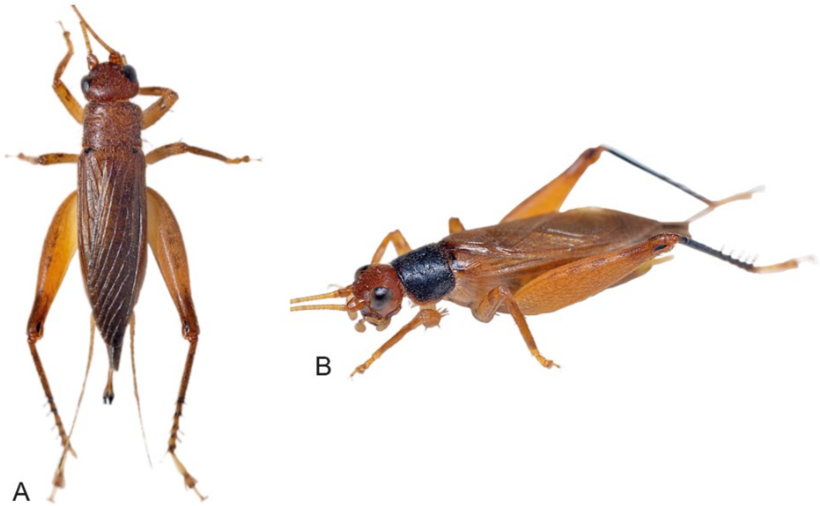


Figure S18. *D. (Diatrypa) tuberculata*. A-female; B-male.

Subfamily PODOSCIRTINAE Saussure, 1878

Podoscirtites Saussure, 1878: 693. Saussure, 1893: 257.

Eneopterinae Kirby, 1906: 92. Chopard, 1968: 365. Chopard, 1969: 326. Vickery, 1977: 14. Otte & Alexander, 1983: 1-477.

Eneopteridae Kevan, 1977: 40.

Podoscirtidae Bruner 1916: 416. Chopard, 1951: 491. Desutter, 1987: 224. Desutter, 1988: 361.

Podoscirtinae Gorochov, 1986: 519. Otte, Alexande & Cade, 1987: 448.Vasanth, 1993: 114. Otte, 1994: 72. Otte, 1994: 86. Oshiro, 1995: 37. Yin, Haisheng & Liu, 1995: 213.Ingrisch, 1997: 48. Gorochov, 2002: 303-350. Gorochov, 2003: 267-303. Gorochov, 2004: 33. Gorochov, 2005: 181-208. Gorochov, 2006: 33-46. Gorochov, 2007: 237-289. Gorochov, 2008: 15. Gorochov, 2010: 205-245. Gorochov, 2011: 216-270. Gorochov, 2013: 15-58. Gorochov, 2015: 31-41. Anso, Jourdan & Desutter-Grandcolas, 2016: 30. Desutter-Grandcolas, Anso & Jourdan, 2016: 436. Gorochov, 2017: 11-106. Gorochov, 2018: 77-121. Rentz & Su, 2019:124. Gorochov, 2020: 248. Gorochov, 2021: 65. Gorochov, 2021: 381-389.Zheng et al. 2021: 401.

Type genus. *Podoscirtus* Serville, 1838.

Distribution. Worldwide.

Diagnosis. Small to large-sized, body generally fusiform, intensely covered by bristles, with developed FWs, sometimes with stridulatory apparatus not developed. TIII with five or more outer and inner subapical spurs. Apex of dorsal valves of ovipositor serrulated laterally and ventrally, covering ventral valves laterally and sometimes ventrally (Fig. S19B, C). Male genitalia: apex of ectophallic fold bilobate; posterior projection of endophallus double (u-shaped) (Fig. S19A) when present; EndAp generally flattened laterally.

Included supertribes and genera:

-Podoscirtidi Saussure, 1878 n. status
-Hapithidi Gorochov, 1986 n. status
-Incertae sedis: *Allopterites* Cockerell, 1920 (fossil)
-Incertae sedis: *Stenogryllodes* Chopard, 1936 (fossil)

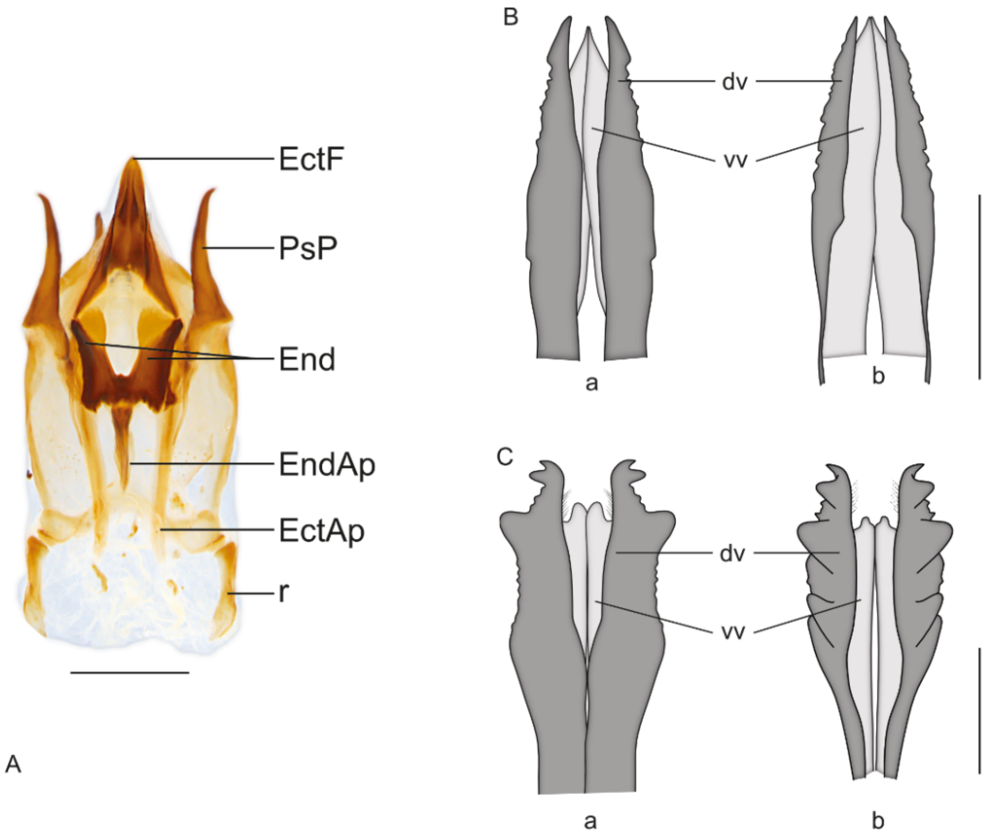


Figure S19. A-*Ultratrella gracilis*, male genitalia, ventral view. B-*Taroba elephantina*, apex of ovipositor: a-dorsal view, b-ventral view. C-*Idiotrella karnyi*, apex of ovipositor: a-dorsal view, b-ventral view. Scales: 1mm. Abbreviations are in material and methods.

Supertribe Podoscirtidi Saussure, 1878 n. status

Podoscirtites Saussure, 1878: 693. Saussure, 1893: 257.

Type genus. *Podoscirtus* Serville, 1838.
Distribution. Afrotropic, Australasia, Indo-Malay, Oceania, and Palearctic.
Diagnosis. FWs and HWs well-developed, frequently covering the entire abdomen, generally with stridulatory apparatus developed (Fig. S20A), sometimes with FWs bearing only longitudinal veins (Fig. S20B). When stridulatory apparatus developed, stridulatory vein (PCu) curved, forming a 90° angle, proximal branch parallel to CuPa (Fig. S20C); CuPa higher than CuPb in lateral view. TI inner tympanum, when present, generally profound. Male genitalia: MedLophi of pseudepiphallic sclerite when present, short; MedLophi dorsal to LLophi (Figs. S8E, S20D).
Included tribes:

-Aphonoidini Gorochov, 1986
-Podoscirtini Saussure, 1878
-Truljaliini Gorochov, 2020 n. status
-*Picogryllus carentonensis* Josse and Desutter-Grandcolas, 2022 (fossil)

Remark. The clade corresponding in our phylogeny to the Podoscirtidi is clearly undersampled. Future phylogenetic studies on this supertribe, including more taxa, will be necessary to organize and verify more tribes as proposed herein. Besides, *Prozvenella bangaloriensis* appears without tribe in ML (Fig. S13) and MP (Fig. S14) trees. In BI this taxon is inside Podoscirtini (Fig. 2). Thus, we decided to maintain this genus as classified in Cigliano *et al.* (2022). For these reasons, we avoid designing subtribes, as the relations between, and definitions of, present-day genus groups are still unclear.

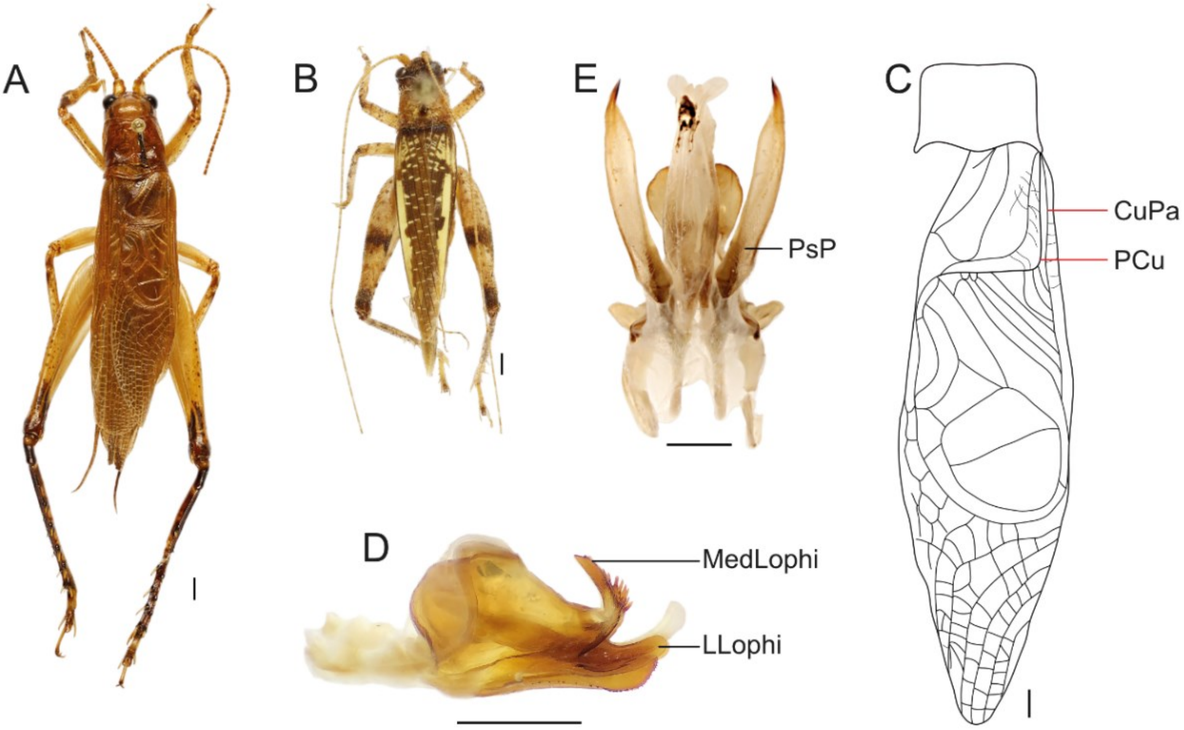


Figure S20. A-*Fryerius* sp., male, dorsal habitus; B-*Munda aff. asyrinx*, male, dorsal habitus; C-*Truljalia hibinonis*, male, pronotum and FW, dorsal view; D-*Madasumma melanotum*, male genitalia, lateral view. Scales: 1mm. Abbreviations: see material and methods.

Tribe Aphonoidini Gorochov, 1986

Aphonoidini Gorochov, 1986: 521. Desutter, 1987: 234. Otte, 1994: 77. Gororchov, 1995: 29. Gorochov, 2007: 237. Gorochov, 2008: 15. Gorochov, 2013: 15-58. Rentz & Su, 2019: 124.

Type genus. *Aphonoides* Chopard, 1940.

Distribution. Afrotropical, Australasia, Indo-Malay, Oceania, and Palearctic.

Diagnosis. Small to medium crickets, TI bearing at least one tympanum. Male: FWs with longitudinal veins, lacking stridulatory apparatus, anal area not delimited (Fig. S20B); subgenital plate longer than wide, posterior margin straight. Male genitalia: spermatophore generally elongated, well-sclerotized. MedLophi absent; endophallic sclerite generally not symmetric Female: subgenital plate posterior margin without median invagination; apex of ovipositor well sclerotized ad in Oecanthinae; apex of dv wider than the rest of ovipositor; vv longer than dv.

Included genera:

- -*Aphasius* Saussure, 1878
- -*Aphonoides* Gorochov, 2008
- -*Corixogryllus* Bolívar, 1900
- -*Gryllaphonus* Chopard, 1951
- -*Munda* Stål, 1877
- -*Umbulgaria* Otte & Alexander, 1983
- -*Utona* Gorochov, 1986
- -genus group *Aphonoides* Gorochov, 2008
    - -*Aphonoides* Chopard, 1940
    - -*Exomunda* Gorochov, 2007
    - -*Furcimunda* Gorochov, 2007
    - -*Zamunda* Gorochov, 2007
- -genus group *Deinutona* Gorochov, 2008
    - -*Deinutona* Gorochov, 2008
    - -*Paputona* Gorochov, 2008
- -genus group *Mistshenkoana* Gorochov, 2008
    - -*Dinomunda* Gorochov, 2007
    - -*Mistshenkoana* Gorochov, 1990
- -genus group *Protomunda* Gorochov, 2008
    - -*Brevimunda* Gorochov, 2007
    - -*Protomunda* Gorochov, 2007
- -genus group *Unka* Gorochov, 2008
    - -*Pseudounka* Gorochov, 2008
    - -*Unka* Otte & Alexander, 1983

Tribe Podoscirtini Saussure, 1878

Podoscirtites Saussure, 1878: 693. Saussure, 1893: 257.

Podoscirtinae Desutter, 1987: 234.

Podoscirtini Chopard, 1968: 365. Otte & Alexander, 1983: 310. Otte, 1994: 72. Otte, 1994: 86. Rentz, 1996: 138. Gorochov, 2004: 187-215. Gorochov, 2010: 206. Rentz & Su, 2019: 156.

Type genus. *Podoscirtus* Serville, 1838.

Distribution. Afrotropical, Australasia, Indo-Malay, Oceania, and Palearctic.

Diagnosis. Small to large size crickets. Male: FWs generally developed bearing stridulatory apparatus, sometimes without hv or mirror (or both). Male genitalia: pseudepiphallic sclerite generally capsular (Figs S7F, S20D); apex of LLophi frequently curved upwards (Fig. S7F). Female: apex of dv of ovipositor pointed, its surface smooth, presence of bristles in apex inner margin (Fig. S19C); apex of vv generally rounded.

Included genera:

-*Abaxitrella* Gorochov, 2002
-*Adenopterus* Chopard, 1951
-*Anaudus* Saussure, 1874
-*Anisotrypus* Saussure, 1878
-*Archenopterus* Otte, 1987
-*Atrella* Gorochov, 2003
-*Calscirtus* Otte, 1987
-*Furcitrella* Gorochov, 2002
-*Fryerius* Uvarov, 1940
-*Hemiphonoides* Chopard, 1951
-*Hemitrella* Gorochov, 2003
-*Heterecous* Saussure, 1897
-*Homalotrypus* Brancsik, 1895
-*Idiotrella* Gorochov, 2002 (transferred from Aphonomorphini)
-*Indotrella* Gorochov, 2003
-*Insulascirtus* Otte & Rentz, 1985
-*Matuanus* Gorochov, 1986
-*Mnesibulus* Stål, 1877
-*Noctitrella* Gorochov, 1990
-*Ocellotrella* Gorochov, 2021
-*Parametrypa* Brunner von Wattenwyl, 1873 (transferred from Paroecanthini)
-*Paranaudus* Saussure, 1878
-*Phyllotrella* Gorochov, 1988
-*Pixipterus* Desutter-Grandcolas, 2016
-*Poliotrella* Gorochov, 1988

- -*Posus* Bolívar, 1890
- -*Prozvenella* Gorochov, 2002
- -*Pseudomadasumma* Shiraki, 1930
- -*Rupilius* Stål, 1876
- -*Scepastus* Gerstaecker, 1863
- -*Trelleora* Gorochov, 1988
- -*Valiatrella* Gorochov, 2005
- -*Varitrella* Gorochov, 2003
- -*Xuanwua* He & Gorochov, 2015
- -*Zvenella* Gorochov, 1988
- -genus group *Hemiphonus* Otte & Alexander, 1983
    - -*Hemiphonus* Saussure, 1878
    - -*Riatina* Otte & Alexander, 1983
- -genus group *Madasumma* Otte & Alexander, 1983
    - -*Madasumma* Walker, 1869
    - -*Tamborina* Otte & Alexander, 1983
- -Subtribe Podoscirtina Saussure, 1878
    - -*Allotrella* Gorochov, 2006
    - -*Atruljalia* Gorochov, 1988
    - -*Brevitrella* Gorochov, 2004
    - -*Eupodoscirtus* Gorochov, 2004
    - -*Kilimagryllus* Sjöstedt, 1910
    - -*Malawitrella* Gorochov, 2021
    - -*Malgasotrella* Gorochov, 2004
    - -*Neozvenella* Gorochov, 2004
    - -*Ombrotrella* Gorochov, 2006
    - -*Podoscirtus* Serville, 1838
    - -*Spinotrella* Gorochov, 2004
    - -*Stenotrella* Gorochov, 2005
    - -*Ultratrella* Gorochov, 2004
    - -*Zvenellomorpha* Gorochov, 2004

Remarks. The genus *Parametrypa* Brunner von Wattenwyl, 1873 was recently transferred to Paroecanthini (Tafaliscinae), a Neotropical tribe (Gorochov, 2021). However, this genus is from the southern African continent, and there are no males described for any species. Male characters are crucial to the classification of Podoscirtinae and Tafaliscinae. The lack of knowledge of this genus and its discrepant distribution supports the reallocation of *Parametrypa* to Podoscirtini again. There is a similar situation for *Idiotrella* Gorochov, 2002. According to Cigliano *et al.* (2022), this genus belongs to Aphonomorphini, a Neotropical tribe. However, the distribution of *Idiotrella* is through southern China and Indonesia. Moreover, the male genital structures and a developed stridulatory apparatus match with Podoscirtini, not Aphonomorphini, which forewings have only longitudinal veins (see Aphonomorphini diagnosis below).

Tribe Truljaliini Gorochov, 2020 n. status

Truljaliina Gorochov, 2020:248.

Type genus. *Truljalia* Gorochov, 1985.
Distribution. Afrotropical, Indo-Malay, and Paleartic.
Diagnosis. Medium to large size crickets. Pronotum DD flattened in lateral view (Fig. S4Bb); TI inner tympanum generally covered by sclerotized tab (Fig. S5I); TIII subapical spurs 6/6 or more. Male: FWs well-developed bearing stridulatory apparatus (Fig. S20C). Male genitalia: PsP generally cylindrical, its tip pointed (Fig. S20E); endophallic sclerite sometimes regressed as in *Truljalia* Gorochov, 1985 and *Sonotrella* Gorochov, 1988.

Included genera:
- *Sonotrella* Gorochov, 1988
- *Truljalia* Gorochov, 1985
- genus group *Dolichogryllus* Gorochov, 2005
    - *Acrophonus* Bolívar, 1910
    - *Afrotruljalia* Gorochov, 2005
    - *Depressotrella* Gorochov, 2005
    - *Dolichogryllus* Bolívar, 1910
    - *Eumadasumma* Chopard, 1934
    - *Hemitruljalia* Gorochov, 2005
    - *Pachyaphonus* Chopard, 1954
    - *Pseudotruljalia* Gorochov, 2005

Supertribe Hapithidi Gorochov, 1986 n. status

Hapithini Gorochov, 1986: 521.
Hapithinae Desutter, 1987: 234. Desutter, 1988: 362.

Type genus. *Hapithus* Uhler, 1864.
Distribution. Nearctic and Neotropic.
Diagnosis. Small to large-sized, FWs generally developed, stridulatory apparatus, present or absent. Lateral and median ocelli almost aligned (Fig. S21A); 5th article of maxillary palpus upcurved almost 90°, sensilla region apical (Fig. S21B); pronotum caudal margin convex on the middle. When stridulatory apparatus present: stridulatory file generally sinuous, with stridulatory file on the mid-length; bearing one or two transversals harp veins, almost parallel to stridulatory file (Figs. S24B, S25B). Female subgenital plate concave or with a median invagination. Male genitalia: EctF apex bilobate; endophallus u-shaped.

Included tribes.
- Aphonomorphini Desutter, 1988
- Cearacesaini Koçak & Kemal, 2010
- Hapithini Gorochov, 1986
- Phyllogryllini Campos n. tribe

Remark. Previously considered a subfamily, we propose this supertribe to organize the classification of Podoscirtinae.

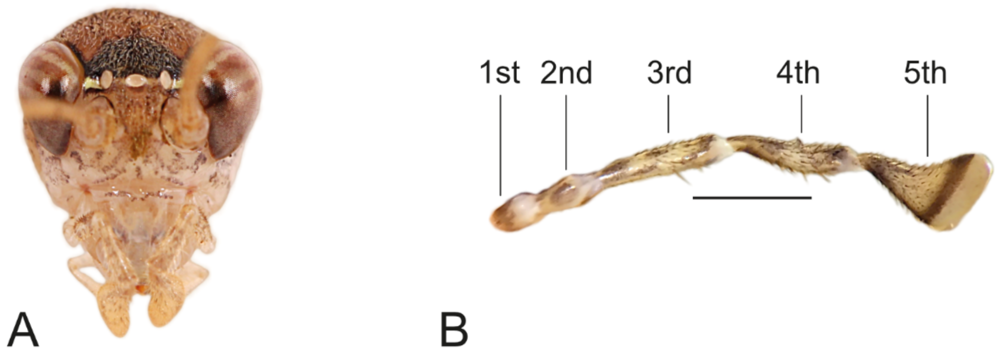


Figure S21. A-*Cearacesa* sp., frontal head; B-*A.(Aphonomorphus) aff. montanus*, maxillary palpus. Scale: 1mm.

Tribe Aphonomorphini Desutter, 1988

Aphonomorphini Desutter. 1988: 362. Otte, 1994: 78. Gorochov, 1995: 29.

Type genus. *Aphonomorphus* Rehn, 1903.
Distribution. Neotropic.
Diagnosis. Medium to large-sized; FWs and HWs developed, surpassing abdomen, FWs without stridulatory apparatus, shorter than HWs (Fig. S22A). Posterior margin of eyes slightly concave (Figs S1Ea, S22B); PCu vein not curved, sometimes with stridulatory teeth on ventral face; TI inner tympana present (except *Paraphonus*), frequently profound; Apical spurs of tarsomere I of leg III same-size or longer than tarsomere I (Fig. S22C, D). Male genitalia: elongated, sometimes asymmetric (Fig. S22E); EctAp elongated; ectophallic arc straight; EndAp well developed, flattened laterally (Figs. S9A, S22E).

Included genera:

-*Aenigmaphonus* Gorochov, 2010
-*Aphonomorphus* Rehn, 1903
-*Eneopteroides* Chopard, 1956
-*Podoscirtodes* Chopard, 1956 (transferred from Podoscirtinae)
-*Paraphonus* Hebard, 1928
-*Spiraphonus* Gorochov, 2010

Remarks. Aphonomorphini do not have a stridulatory apparatus. However, several representatives of this group, like *Aphonomorphus* and *Eneopteroides,* have stridulatory teeth in the ventral face of the PCu vein, which is not curved. These crickets also have tympana on TI, indicating that they could emit acoustic signals or avoid predators. There are no records of acoustic communication within this tribe. The genus *Podoscirtodes* was included in the Podoscirtinae subfamily (Cigliano *et al.*, 2022), but it does not belong to any group inside this subfamily. The characteristics mentioned in the diagnosis above fit this genus characteristics, allowing its transfer to Aphonomorphini. Furthermore, the records of *Podoscirtodes* are all from Neotropical region (Cigliano *et al.*, 2022), which match the distribution of the Aphonomorphini tribe.

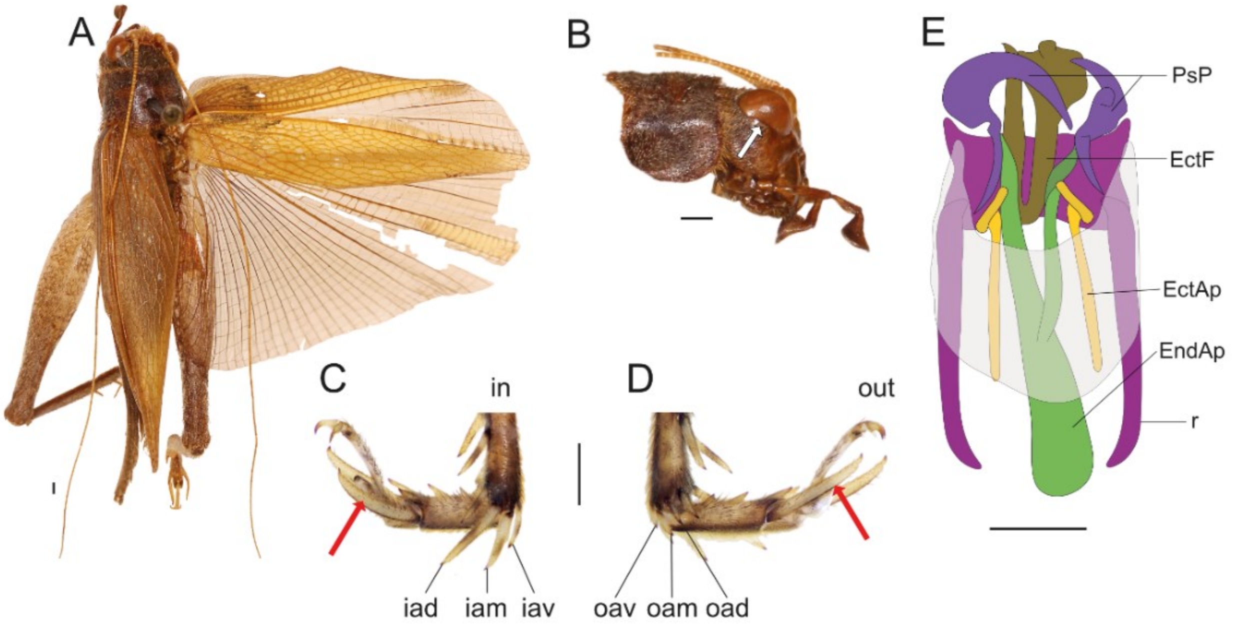


Figure S22. *Eneopteroides bicolor*: A- male, dorsal habitus; B-head and pronotum, lateral view. *A. (Aphonomorphus) aff. montanus*: C-hind tibia distal margin and tarsi, inner view; D-hind tibia distal margin and tarsi, outer view. E-*A.(Euaphonus*) sp., male genitalia, ventral view. Scales: 1mm. Abbreviations: see material and methods.

Tribe Cearacesaini Koçak & Kemal, 2010

Neomorphini Desutter, 1988: 364. Otte, 1994: 80.
Cearacesaini Koçak & Kemal, 2010: 155. Desutter-Grandcolas, 2017: 117-124.
Cearacesaina Gorochov, 2017: 54.

Type genus. *Cearacesa* Koçak & Kemal, 2010 (for *Neomorphus* Desutter, 1988).

Distribution. Neotropic, only South America.

Diagnosis. Small to medium-sized, FWs and HWs developed (except *Taroba elephantina*), surpassing abdomen, without stridulatory apparatus (Fig. S23A). Eyes crossed by horizontal bands, generally two or three (Figs. S1F, S21A, S23A); veins of lateral field of FWs parallel to dorsal field; TIII with 5/5 subapical spurs, sometimes six on inner side. Male genitalia: rami connected anteriorly (Figs. S8I, S23B); ectophallic arc connected.

Included genera:

-*Barota* Gorochov, 2017
-*Cearacesa* Koçak & Kemal, 2010
-*Najtaecesa* Desutter-Grandcolas, 2017
-*Taroba* de Mello & Souza-Dias, 2010

Remarks. Like Aphonomorphini crickets, Cearacesaini have developed FWs without stridulatory apparatus. However, this group does not have stridulatory teeth on the ventral face of the PCu vein, suggesting that these crickets do not use their tympana for acoustic communication. Their external morphology is very similar between the species of this tribe, so male genitalia are necessary for their identification. This is the unique oecanthid taxa with ectophallic arc complete (Fig. S23B).

Figure S23. A-*Cearacesa* sp., male; B-*Cearacesa cearensis*, male genitalia, dorsal view. Scale: 1mm. Abbreviations: see material and methods.

Tribe Hapithini Gorochov, 1986

Hapithini Gorochov, 1986: 521. Desutter, 1987: 234. Otte, 1994: 79. Desutter-Grandcolas & Bland, 2003: 48. Gorochov, 2017: 13.

Type genus. *Hapithus* Uhler, 1864.
Distribution. Neotropic and southern Nearctic.
Diagnosis. Small to medium-sized, FWs developed, sometimes brachypterous (*Margarettia* and *Knyella*), bearing a well-developed stridulatory apparatus (Fig. S24A). Male metanotum sometimes with median projection; FWs mirror with or without a dividing vein, generally shorter than apical field (Fig. S24B); tympana frequently present on both sides of TI; TIII subapical spurs generally 8/6, with variations from five to ten on inner margin and from five to seven on outer margin; apical spurs of tarsomere I of leg III shorter than tarsomere I of leg III. Ovipositor ventral valves laterally serrulated. Male genitalia: LLophi dorsal to MedLophi (Figs. S8D, S24C); PsP lateral and connected to pseudepiphallic (Fig. S8C); EctF bilobate and connected distally, proximal portion convex (forming dorsal cavity) in dorsal and ventral views (Fig. S8C).

Included genera:
-*Carylla* Otte & Perez-Gelabert, 2009
-*Hapithus* Uhler, 1864
-*Hapithoides* Hebard, 1928
-*Jabulania* Otte & Perez-Gelabert, 2009
-*Knyella* Otte & Perez-Gelabert, 2009
-*Laurellia* Otte & Perez-Gelabert, 2009
-*Margarettia* Otte & Perez-Gelabert, 2009
-*Sabelo* Otte & Perez-Gelabert, 2009
-*Sipho* Otte & Perez-Gelabert, 2009
-*Stenogryllus* Saussure, 1878
-*Walkerana* Otte & Perez-Gelabert, 2009

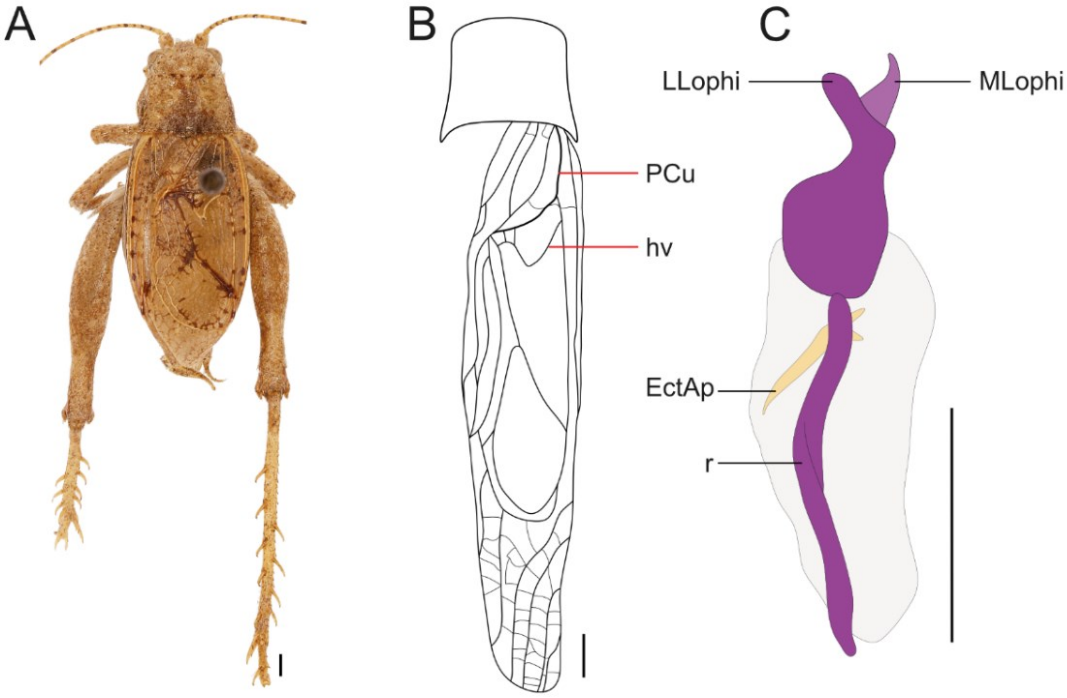


Figure S24. A-*Hapithus vagus*, male, dorsal habitus; B-*Stenogryllus* sp., male, pronotum and FW, dorsal view; C-*Hapithus* sp., male genitalia, lateral view. Scales: 1mm. Abbreviations: see material and methods.

Tribe Phyllogryllini Campos n. tribe

Type genus. *Phyllogryllus* Saussure, 1878.

Distribution. Neotropic.

Diagnosis. Medium to large-sized, FWs well-developed, surpassing abdomen, bearing a stridulatory apparatus, HWs longer than FWs (Fig. S25A). Lateral and median ocelli connected laterally or remarkably close to each other (Fig. S1D, S25C); pronotum DD flattened in lateral view (Fig. S4Bb); FWs lateral field shorter than dorsal field; TIII with 6 or 7 inner and 4-6 outers subapical spurs; apical spurs of tarsomere I of leg III same-size or longer than tarsomere I. Male genitalia: MedLophi absent; anterior margin of pseudepiphallic sclerite up-curved (Fig. S8F); r shorter than pseudepiphallic sclerite (Fig. S25D). Female's copulatory papilla generally poorly sclerotized, sometimes almost no discernible.

Remark. Considered anteriorly as Hapithini, this new tribe appears as a separated lineage of the other tribes of Hapithidi (Figs. 2, S13, S14). Despite there are no morphological synapomorphies in this clade, the morphological characters mentioned in the diagnosis also support this hypothesis.

Included genera:

- -*Gryllophyllus* Gorochov, 2017
- -*Phyllogryllus* Saussure, 1878
- -*Somnambula* Gorochov, 2017

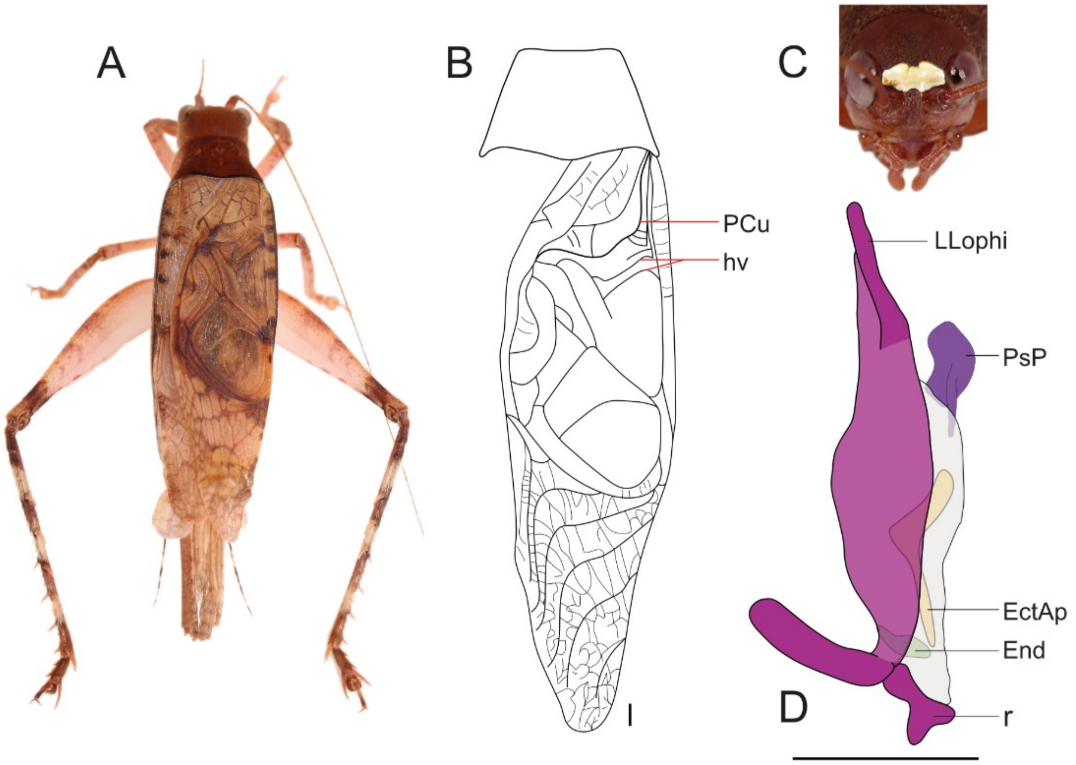


Figure S25. A-*Phyllogryllus velutinus*, male, dorsal habitus; B-*Gryllophyllus* sp., male, pronotum and FW, dorsal view. *Phyllogryllus* sp.: C-frontal head; D-male genitalia, lateral view. Scales: 1 mm. Abbreviations: see material and methods.

Subfamily TAFALISCINAE Desutter, 1988 n. status

Tafaliscinae Desutter, 1988: 367.

Tafaliscini Desutter, 1988: 367. Otte, 1994: 68. Gorochov, 1995:1-213.

Tafaliscina Gorochov, 2011: 254. Gorochov, 2017: 87. Campos, Souza-Dias & Nihei, 2020: 333. Campos & Desutter-Grandcolas, 2020: 393.

Type genus. *Tafalisca* Walker, 1869.

Distribution. Neotropic.

Diagnosis. Small to large-sized, FWs absent, brachypterous or well-developed wings (with or without stridulatory apparatus) (Figs. S2A-C, S27A, S28A, S29A). 5th and 4th articles of maxillary palpi with similar size, 5th article slightly upcurved (Fig. S26A); when FWs with stridulatory apparatus present; stridulatory file sinuous or bisinuous (Paroecanthini): proximal connection of harp veins generally present. FIII generally longer than TIII; TIII subapical spurs 5/4 (Fig. S6B) (except some Paroecanthini 5/5 and *Perutrella* 4/3). Ovipositor flattened dorso-ventrally, upcurved in lateral view; apex of dorsal valves above ventral valves (Fig. S26B); apex lateral margins of ventral valves of ovipositor smooth (Fig. S26Cb). Male genitalia: inner margin of LLophi frequently membranous (Fig. S7A, C).

Included supertribes.

-Paroecanthidi Gorochov, 1986 n. status
-Tafaliscidi Desutter, 1988 n. status

Remark. After its proposal (Desutter, 1988), this subfamily was considered as a tribe (Gorochov, 1995) and posteriorly a subtribe (Gorochov, 2011) within the Podoscirtinae subfamily. The results presented here, including the topologies and their synapomorphies, support the hypothesis that this neotropical lineage is a subfamily of Oecanthidae composed of two supertribes redefined below, i.e., Paroecanthidi and Tafaliscidi.

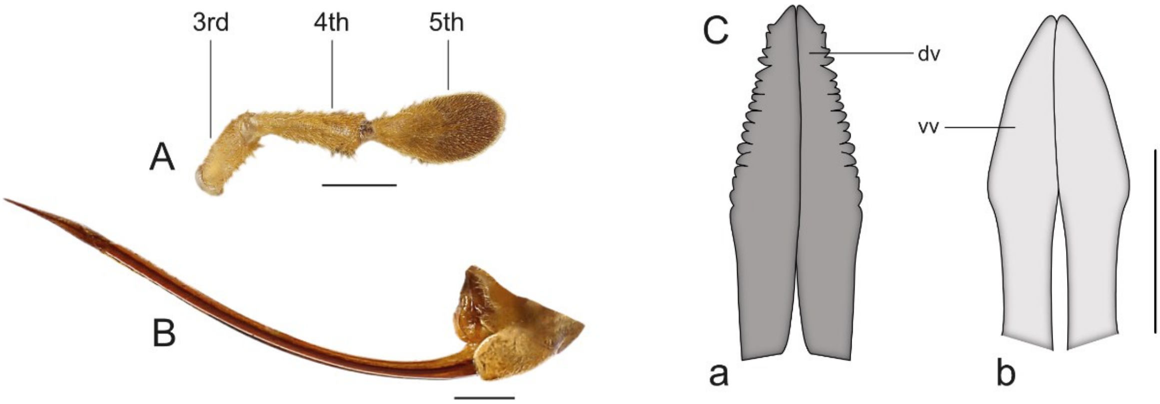


Figure S26. A-*Tafalisca elongata elongata*, maxillary palpus; B-*Apterotrypa mitarakensis*, ovipositor, lateral view; C-*Angustitrella vicina*, apex of ovipositor: a-dorsal view; b-ventral view. Scales: 1mm. Abbreviations: see material and methods.

Supertribe Paroecanthidi Gorochov, 1986 n. status

Paroecanthini Gorochov, 1986:516. Desutter, 1987: 235. Desutter, 1988: 369. Otte, 1994: 68. Gorochov, 2011: 217. Gorochov, 2017: 81. Campos, Souza-Dias & Nihei, 2020: 333. Campos & Desutter-Grandcolas, 2020: 356.

Type genus. *Paroecanthus* Saussure, 1859.
Distribution. Neotropic.
Diagnosis. Small to medium-sized crickets, FWs developed, brachypterous or without wings. Pronotum as wide as long or longer than wide; metanotal structures frequently present (Fig. S4C, E). Apex surface of dorsal valves of ovipositor wrinkled (Fig. S26Ca). Male genitalia: EndAp absent (Figs. S8B, H; S28C).

Included tribes:
- Paroecanthini Gorochov, 1986
- Neometrypini Desutter, 1988

Tribe Paroecanthini Gorochov, 1986

Paroecanthini Gorochov, 1986:516. Desutter, 1987: 235. Desutter, 1988: 369. Otte, 1994: 68. Gorochov, 2011: 217. Gorochov, 2017: 81. Campos, Souza-Dias & Nihei, 2020: 333. Campos & Desutter-Grandcolas, 2020: 356.
Paroecanthina Gorochov, 2011:218. Gorochov, 2017: 81. Campos & Desutter-Grandcolas, 2020: 393.

Type genus. *Paroecanthus* Saussure, 1859.
Distribution. Neotropic.
Diagnosis. Small to medium-sized, body somewhat flattened dorso-ventrally, FWs well-developed bearing stridulatory apparatus (Fig. S27A). TI inner tympanum generally profound, sometimes covered by a sclerotized tab (Fig. S5I); FWs stridulatory file bisinuous (Fig. S3Bc) with stridulatory teeth on proximal region; hv divided into two or more clusters (Fig. S27B); lateral field forming a >90° angle with dorsal field (observed in posterior view, Fig. S2J2). Male genitalia: generally reduced, mainly ectophallic invagination and endophallus (Figs. S8B, S27C) (except

Adenophallusia); MedLophi frequently absent; r two or more times longer than pseudepiphallic sclerite (Figs. S8B; S27C; S30H, I).

Included genera:

-*Adenophallusia* de Mello & de Camargo e Mello, 1996 (Tafaliscina)
-*Angustitrella* Gorochov, 2011
-*Bofana* Otte & Perez-Gelabert, 2009
-*Ectotrypa* Saussure, 1874
-*Paroecanthus* Saussure, 1859
-*Prodiatrypa* Desutter, 1988 (transferred from Tafaliscina)
-*Selvagryllus* Otte, 2006
-*Siccotrella* Gorochov, 2011

Remarks. This supertribe, recently transferred for Oecanthinae (Campos and Desutter-Grandcolas, 2020), was anteriorly considered a tribe of Tafaliscinae (Desutter, 1988), corroborating in part with our results. The genus *Prodiatrypa* Desutter, 1988 has all the diagnostic characteristics of Paroecanthini, like stridulatory veins bisinuous and regressed genital structures of males. Because of this, it is transferred to this tribe. *Adenophallusia* de Mello & de Camargo e Mello, 1996 also has several Paroecanthini characters, like the bisinuous stridulatory file, the tip of the apex of the ovipositor rounded, and the dorsal valves surface wrinkled. Besides, the phylogeny presented herein shows *Adenophallusia* belonging to the Paroecanthini clade. This relationship is not well supported. However, the morphological evidence indicates a close relationship between *Adenophallusia* and Paroecanthini crickets.

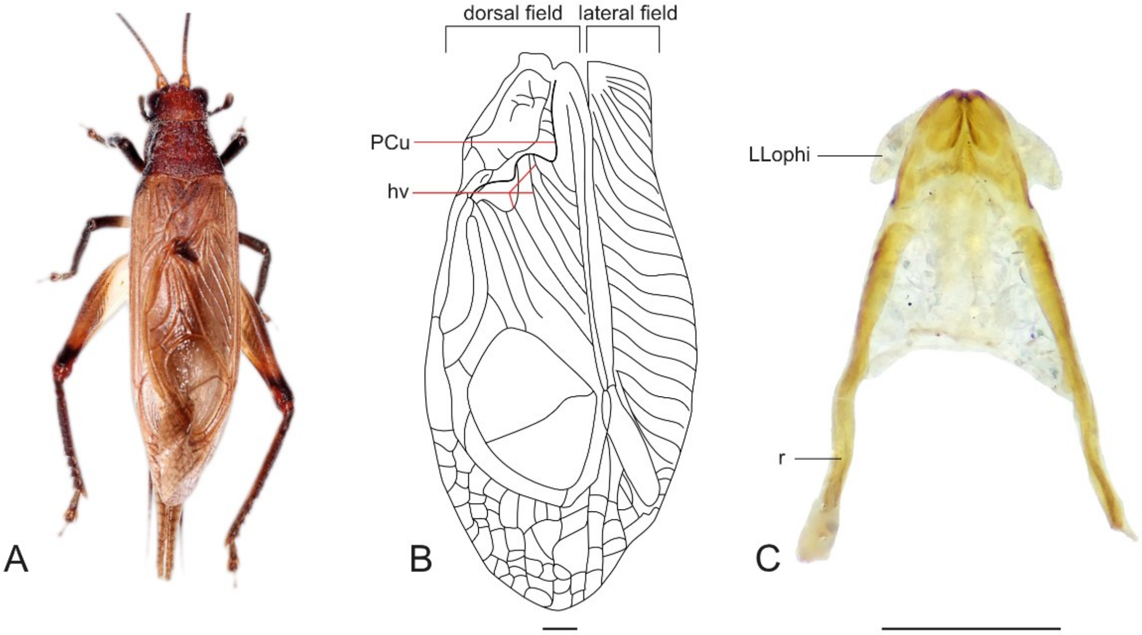


Figure S27. *Angustitrella* sp., male: A-dorsal habitus; B-right FW. B-*Paroecanhtus aztecus*, male genitalia, dorsal view. Scales: 1 mm. Abbreviations: see material and methods.

Tribe Neometrypini Desutter, 1988

Neometrypini Desutter, 1988:367. Otte, 1994: 68.

Neometrypina Gorochov, 2010: 207.

Type genus. *Neometrypus* Desutter, 1988.

Distribution. Neotropic, only South America.

Diagnosis. Small to medium-sized crickets with elongated body, fusiform. Pronotum longer than wide; median projection of metanotum present, generally single (Figs. S4E, S28B); apterous (Fig. S2A), brachypterous (Fig. S2B) or with developed wings (Fig. S28A), but without stridulatory apparatus, only with longitudinal veins; TI tympana absent. Apex of dorsal valves of ovipositor wrinkled. Male genitalia: MedLophi absent; pseudepiphallic apodeme present (Figs. S8H, S28C); apex of PsP bilobate; endophallic sclerite flattened dorso-ventrally.

Included genera:

- -*Apterotrypa* Gorochov, 2017, n. status
- -*Brazitrypa* Gorochov, 2011
- -*Cylindrogryllus* Saussure, 1878

-*Dicerorostrum* Gorochov, 2017 (transferred from Podoscirtinae)
-*Neometrypus* Desutter, 1988
-*Nessa* Walker, 1869 (transferred from Podoscirtinae)

Remarks. This group is reestablished with the presented results, corroborating its initial proposal (Desutter, 1988). This tribe has strong evidence suggesting that there is no acoustic communication in this group. FW veins are not modified for sound production; they are reduced (brachypterous), or absent, and tympana are absent. The description of the genus *Nessa* seems to be remarkably similar to *Brazitrypa*. However, the type species of the genus were not examined. Therefore, the genus is still valid, but it is transferred here from Podoscirtini to Neometrypini due to its similar morphological characteristics of *Brazitrypa* and its neotropical distribution. A similar situation happens to *Dicerorostrum*, which has the characteristics of Neometrypini crickets, i.e., FWs with longitudinal veins, MedLophi of male genitalia absent, apex of PsP bilobate, endophallic sclerite flattened dorso-ventrally; it is also neotropical in distribution. These features allow transferring *Dicerorostrum* from Podoscirtinae *incertae sedis* to Neometrypini.

According to the phylogenetic analysis results presented herein, the two subgenera of *Cylindrogryllus* are actually different genera, i.e., *Cylindrogryllus* and *Apterotrypa*. In the same way, the genus *Neometrypus*, previously considered a subgenus of *Cylindrogryllus* (Gorochov, 2017), was recently reassigned to the genus level (Campos and Souza-Dias, 2021), which is supported by our topology. The phylogenetic analysis also shows that *Tafalisca bahiensis* belongs to the genus *Brazitrypa*. Taxonomists frequently mixed up *Brazitrypa* and *Tafalisca* identifications (Campos and Desutter-Grandcolas, 2020) due to their very similar external morphology, with longitudinal veins on FWs. The morphological characters such as the lack of ocelli, ovipositor apex pointed, copulatory papilla triangular, and flattened dorso-ventrally corroborate this nomenclatural act.

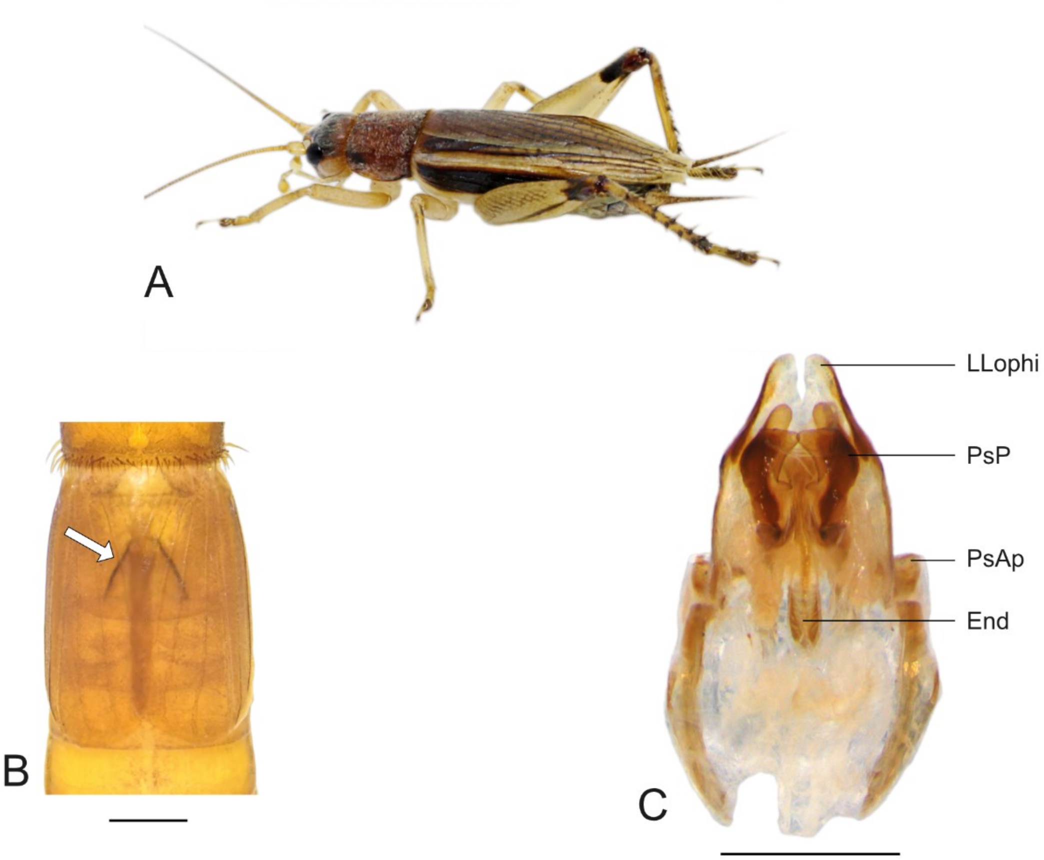


Figure S28. A-*Brazitrypa paulista*, male; B-*Cylindrogryllus pitanga*, male, FWs and metanotum; C-*Neometrypus badius*, male genitalia, ventral view. Scales: 1 mm. Abbreviations: see material and methods.

Supertribe Tafaliscidi Desutter, 1988 n. status

Tafaliscini Desutter, 1988: 367. Otte, 1994: 68. Gorochov, 1995:1-213.
Tafaliscina Gorochov, 2011: 254. Gorochov, 2017: 87. Campos, Souza-Dias & Nihei, 2020: 333. Campos & Desutter-Grandcolas, 2020: 393.

Type genus. *Tafalisca* Walker, 1869.
Distribution. Neotropic.
Diagnosis. Medium to large-sized crickets, body fusiform. Lateral ocelli rounded, larger than central one; FWs well-developed with longitudinal veins (Fig. S29A) or with stridulatory apparatus developed (Figs S2C, S29B). When stridulatory apparatus developed: anal field bulged, sinuosity of PCu vein close to lateral field (Fig. S29B), apical field longer than mirror. TI with tympanum except for the majority of *Tafalisca* species. TIII subapical spurs and spines strong (Fig. S6B). Tip of dorsal and ventral

valves of ovipositor truncated (Figs S5B, S29C) Male genitalia: MedLophi and LLophi connected by a membrane; lateral margins of endophallic sclerite folded in ventral view (Figs S7A, C; S8A; S29D).

Included genera:

- *Amblyrhethus* Kirby, 1906
- *Eubezverkhovia* Gorochov & Izerskyy, 2020
- *Mexitrypa* Gorochov, 2011
- *Perutrella* Gorochov, 2011
- *Stenaphonus* Saussure, 1878 (transferred from Podoscirtini)
- *Tafalisca* Walker, 1869
- *Veredatrypa* Campos, 2020

Remarks. This clade is elevated from subtribe to tribe based on the phylogenetic results and the taxonomic organization presented here. There are only two genera of Tafaliscidi without stridulatory apparatus developed: *Tafalisca* and *Stenaphonus*. However, most of the species of *Tafalisca* have a curved PCu vein and stridulatory teeth on ventral face of this vein. This condition suggests that *Tafalisca* could use acoustic communication or produce vibration using its FWs (Campos and Desutter-Grandcolas, 2020). Once there are no structures to propagate the sound like a mirror or harp veins. The genus *Stenaphonus* has characteristics in common with Tafaliscidi, mainly with *Tafalisca* crickets. Some characters support the replacement of *Stenaphonus* from Podoscirtini to Tafaliscidi: lateral ocelli large and rounded; TIII subapical spurs 5/4; FWs bearing longitudinal veins; ovipositor flattened dorso-ventrally, and neotropical distribution (Saussure, 1878).

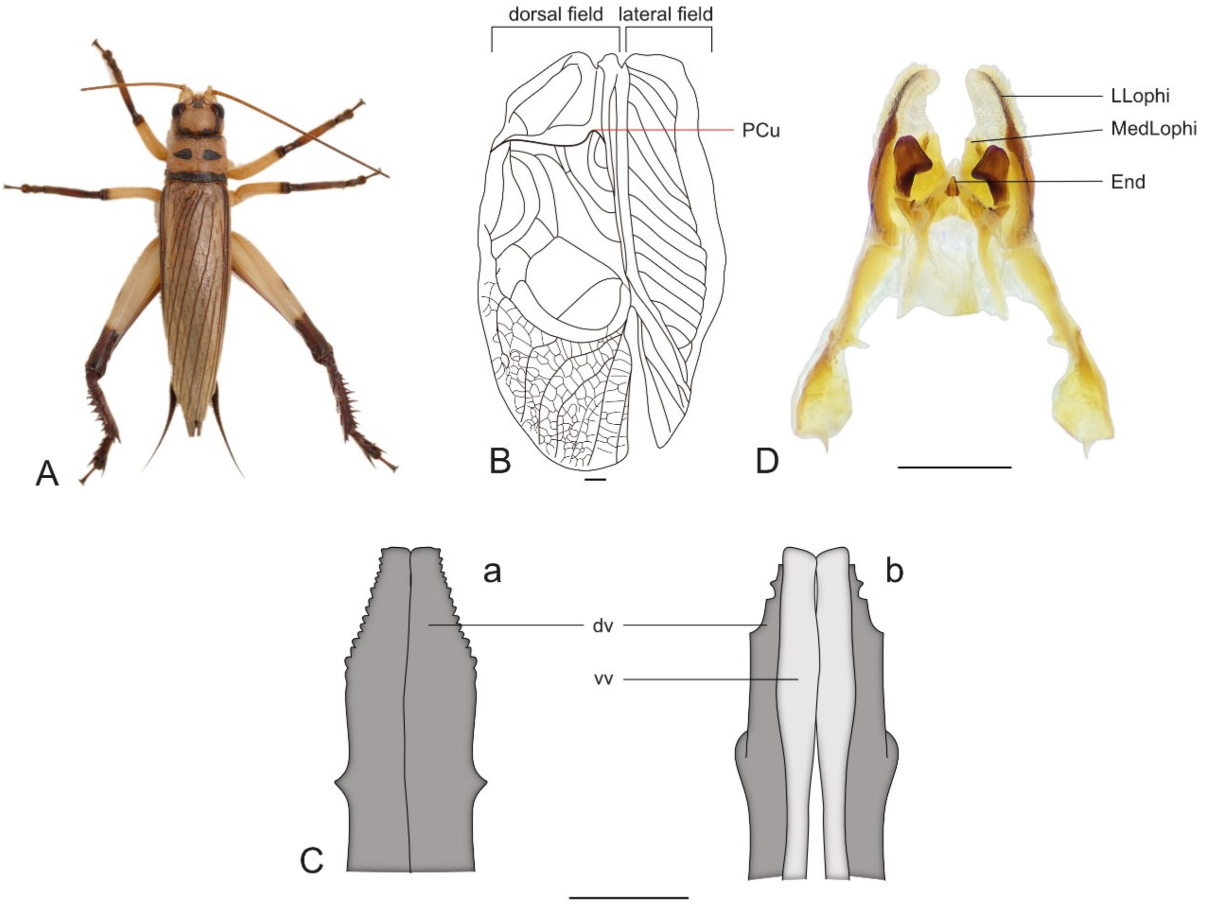


Figure S29. A-*Tafalisca elongata elongata*, male, dorsal habitus; B-*Amblyrhethus* sp., male, right FW; C-*Tafalisca* sp., apex of ovipositor: a-dorsal view, b-ventral view. D-*Tafalisca furfurosa*, male genitalia, ventral view. Scales: 1 mm. Abbreviations: see material and methods.

References

Campos, L.D. de, Souza-Dias, P.G.B. 2021. Hidden in the bushes: uncovering the diversity of the genus *Neometrypus* Desutter, 1988 n. status (Orthoptera: Gryllidae: Paroecanthini: Tafaliscina) in Neotropical forests. Zootaxa. 5060, 451–488. doi:10.11646/zootaxa.5060.4.1

Campos, L.D. de, Desutter-Grandcolas, L. 2020. The Paroecanthini crickets (Orthoptera: Grylloidea: Gryllidae: Oecanthinae) from French Guiana. Zoosystema. 42, 355–398. doi:10.5252/zoosystema2020v42a20

Chintauan-Marquier, I.C., Legendre, F., Hugel, S., Robillard, T., Grandcolas, P., Nel, A., Zuccon, D., Desutter-Grandcolas, L. 2016. Laying the foundations of evolutionary and systematic studies in crickets (Insecta, Orthoptera): a multilocus phylogenetic analysis. Cladistics. 32, 54–81. doi:10.1111/cla.12114

Cigliano, M.M., Braun, H., Eades, D.C., Otte, D. 2022. Orthoptera Species File. Version 5.0/5.0 [WWW document] [WWW Document]. URL http://orthoptera.speciesfile.org (accessed 01.07.21).

Desutter, L. 1988. Structure et évolution du complexe phallique des Gryllidea (Orthoptères) et classification des genres Nèotropicaux de Grylloidea.-Deuxième Partie. Annales de la Societé entomologique de France. 24, 342–373.

Gorochov, A.V. 2021. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 13: new taxa of the subtribe Podoscirtina from Africa. Zoosystematica Rossica. 30, 64–77. doi:10.31610/zsr/2021.30.1.64

Gorochov, A.V. 2017. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 11: the tribe Hapithini and other American taxa. Zoosystematica Rossica. 26, 11–106.

Gorochov, A.V. 2011. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 9: the American tribe Paroecanthini. Zoosystematica Rossica. 20, 216–270.

Gorochov, A.V. 1995. System and evolution of the suborder Ensifera (Orthoptera). Proceedings of the Zoological Institute, Russian Academy of Sciences. 260, 3–224.

Saussure, H. de. 1878. Melanges orthopterologiques: gryllides. VI. fascicule Gryllides.. Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. 25, 369–704.

Appendix 4 – Identification Keys

Identification key to Oecanthidae n. status subfamilies, supertribes, and tribes

1. -Fastigium truncated in frontal and lateral views (Figs. 5B, S1G), male anterolateral region of metanotum not inflated, tarsal claws inner margin serrulated (Figs S6Gb, S15C), TIII bearing six or more inner subapical spurs (Fig. S6Gb)..**Euscyrtinae** Gorochov, 1985

   -Fastigium not truncated in frontal and lateral views (Fig. S1A-C, I), male anterolateral region of metanotum inflated (Fig. S4C-E), TIII bearing maximum six inner subapical spurs (except some Podoscirtinae taxa bearing more than six), claws inner margins not serrulated (Fig. S6Ga)………………………….…………….**2**

2. -Ventral inner apical spur of TIII very reduced or absent (Fig. S6E), FWs lateral field with an angle less than 90° related to dorsal field in posterior view (Fig. S2J2), ovipositor straight in lateral view (Fig. S4Jb), tip of ovipositor dorsal valves forked (Fig. S4Ja, S5C). Male genitalia: rami two or more times longer than pseudepiphallic sclerite………………………….……**Oecanthinae** Blanchard, 1945…**4**

   -Ventral inner apical spur of TIII developed (Fig. S6D), FWs lateral field with an angle ~90° related to dorsal field in posterior view (Fig. S2J1), ovipositor up or downcurved in lateral view (Fig. S4K, L), tip of ovipositor dorsal valves single. Male genitalia: rami slightly longer or shorter than pseudepiphallic sclerite ……..…...**3**

3. -Posterior margin of pronotum convex in the middle (Fig. S4Aa). TIII with 5/5 subapical spurs or more. Ovipositor not flattened (Fig. S4J, L), apex of dorsal valves covering ventral valves laterally and sometimes ventrally (Figs S5A, D, E, G; S19B, C), generally strongly sclerotized, laterals strongly serrulated, laterals of apex of ventral valves generally smooth. Male genitalia: inner margin of LLophi not membranous; ectophallic fold single or bilobate, posterior projection of endophallic sclerite, when present, bilobate (Fig. S19A); endophallic apodeme, when present, flattened laterally (Figs. S9A, S19A, S22E)…….**Podoscirtinae** Saussure, 1878…**6**

-Posterior margin of pronotum entirely convex (Fig. S4Ab). TIII with 5/4 subapical spurs (4/3 in *Perutrella* and 4/4 in some Paroecanthini). Ovipositor flattened dorso-ventrally (Figs S4K, S26B), apex of dorsal valves above ventral valves (Figs S5B, F, H; S26C), same sclerotization as the entire ovipositor, laterals slightly or not serrulated; laterals of apex of ventral valves generally serrulated. Male genitalia: Inner margin of LLophi generally membranous (Figs S7A, S28E, S29D); ectophallic fold single, posterior projection of endophallic sclerite, when present, single; endophallic apodeme, when present, not flattened laterally (Fig. S8L-N)……………………………………….……..…**Tafaliscinae** Desutter, 1988…**12**

4. -Specimens hypognathous (Fig. S18B); TI and TII ventral inner apical spurs present (Fig. S5O, P); FIII proximal portion wider than distal portion in lateral view (Fig. S4K, S6A); 1st tarsomere of leg III with dorsal spines (Fig. S22C, D); tarsal claws not bifurcated (Fig. S6Ga). Tip of ventral valves of ovipositor forked. Male FW: mirror not occupying more than half of FW (Fig. S2E, G), with one dividing vein; apical field present (Fig. S5J, S6C, D). Male genitalia: ectophallic arc curved posteriorly; ventral valves present, larger than the entire genitalia (Fig. S9C); endophallic sclerite two times or longer than pseudepiphallic sclerite (Fig. S7D). Neotropical distribution……..……..**Diatrypidi** n. status/**Diatrypini** Desutter, 1988
-Specimens prognathous (Figs S1K, S16A); TI and TII ventral inner apical spurs absent; FIII proximal portion similarly thin to distal portion in lateral view; 1st tarsomere of leg III without spines (Fig. S17B, C); tarsal claws bifurcated (Figs S6Gc, S16C). Tip of ventral valves of ovipositor not forked. Male FW (when developed): large mirror occupying almost or more than half of FW, with two dividing veins (Figs S3H, S16B); apical field absent or almost no discernible (Fig. S3H). Male genitalia: ectophallic arc curved anteriorly (Fig. S8G); ventral valves poorly developed or absent; endophallic sclerite short (Fig. S8G). Worldwide distribution…………………………….………...………….…..…**Oecanthidi** n. status…**5**

5. -Cerci short, shorter than FII (Fig. S4G); ventral extern apical spur of TII present; subapical spurs of TIII absent (Fig. S17A); ventral outer and inner apical spurs of TIII absent (2/2) (Fig. S17B, C), 1st tarsomere apical spurs of leg III absent. Male genitalia: distal prolongation of ectophallic arc absent…………………………….……………………..**Xabeini** Vickery & Kevan, 1983

-Cerci long, longer than FII (Fig. S4H); ventral extern apical spur of TII absent; subapical spurs of TIII present, generally 3/3; ventral outer and inner apical spurs of TIII present (3/3); 1st tarsomere apical spurs of leg III present. Male genitalia: distal prolongation of ectophallic arc present (Fig. S8G)…………………………..………………**Oecanthini** Blanchard, 1945

6. -Median and lateral ocelli generally aligned (Figs S1B, S21A); 5th article of maxillary palpi upcurved 90° (Figs S1Lc, S21B, S22B). Male FWs: PCu vein curved more than 90°, sinuous (Figs S3Bb, G; S24B; S25B;); CuPa not parallel to proximal region of PCu (Figs S3G, S24B, S25B); harp veins, when present, parallel to PCu vein (Figs S3G, S24B, S25B). New world distribution……………………..………………………...**Hapithidi** n. status…**7**

-Median and lateral ocelli not aligned; 5th article of maxillary palpi slightly upcurved (Fig. S1Lb). Male FWs: PCu vein curved 90°, not sinuous (S3Ba, F; Figs S20C); CuPa parallel to proximal region of PCu (Figs S3F, S20C); harp veins, when present, diagonal (Figs S3F, S20C). Old world distribution……………………….…………………...**Podoscirtidi** n. status…**10**

7. -Veins of lateral field parallel to dorsal field (Fig. S2Ia). Male FWs: stridulatory apparatus absent (Fig. S3A); apical field not delimited…………………….…..…**8**

-Veins of lateral field perpendicular to dorsal field (Fig. S2Ib). Male FWs: stridulatory apparatus present; apical field delimited (Fig. S3F, G)……..…………**9**

8. -Eyes posterior margin concave in lateral view (Figs S1Eb, S22B), with one horizontal band or without bands; TI outer tympana generally present, inner absent; 1st tarsomere apical spurs of leg III longer than the tarsomere (Fig. S22C, D). Male genitalia: ectophallic arc not connected (Figs S9A, S22E); endophallus u-shaped (Figs S9A, S22E), endophallic apodeme two or more times longer than PsP (Figs S9A, S22E); rami not connected……..…..……..**Aphonomorphini** Desutter, 1988

-Eyes posterior margin straight in lateral view (Fig. S1Ea); eyes with two or three horizontal bands (Figs S1F, S21A, S23A); TI outer tympana absent, inner present; apical spurs of 1st tarsomere of leg III generally same size or shorter than the tarsomere. Male genitalia: ectophallic arc connected (Figs S8I, S23B); endophallus not u-shaped, endophallic apodeme same shorter or slightly longer than PsP; rami connected (Figs S8I, S23B)………..……..………**Cearacesaini** Koçak & Kemal, 2010

9. -Median and lateral ocelli distant, not connected. FWs lateral and dorsal field same-sized (Fig. S2H1). Pronotum caudal margin entirely convex (Figs S4Ab, S24A). Dorsal valves of ovipositor lateral margins slightly serrulated, same color as the entire ovipositor. Male genitalia: MedLophi present (Figs S8C, S24C); anterior margin of pseudepiphallic sclerite not folded; ectophallic arc reduced or absent……………………………..……..…………**Hapithini** Gorochov, 1986

   -Median and lateral ocelli remarkably close, sometimes connected (Figs S1B, D; S25C). FWs lateral field shorter than dorsal field (Fig. S2H2). Dorsal valves of ovipositor lateral margins strongly serrulated, darker than the entire ovipositor (Fig. S5A, E). Pronotum caudal margin convex on the middle (Figs S4Aa, S25A). Male genitalia: MedLophi absent; anterior margin of pseudepiphallic sclerite folded dorsally (Figs S8F, S25D); ectophallic arc present…………..**Phyllogryllini** n. tribe

10. -Male FWs without stridulatory apparatus, only longitudinal veins, anal area not delimited; male genitalia PsP not cylindrical; endophallus asymmetric; apex of dorsal valves of ovipositor generally wider than entire ovipositor in dorsal and ventral views……………………………..……....**Aphonoidini** Gorochov, 1986

    -Male FWs generally bearing stridulatory apparatus sometimes harp veins or mirror lacking (or both), anal area delimited; male genitalia PsP frequently cylindrical; endophallus frequently symmetrical; apex of dorsal valves of ovipositor generally same width of the entire ovipositor in dorsal and ventral view……………………………….…………………………..…………..**11**

11. -TI inner tympanum usually not covered by a sclerotized tab; pronotum DD not flattened in lateral view; Male genitalia generally capsular (Fig. S7F); arc and ventral projection of ectophallic invagination short, endophallus well-developed…………………..……………………..…..**Podoscirtini** Saussure, 1878

    -TI inner tympanum covered by a sclerotized tab; pronotum DD not flattened in lateral view; Male genitalia not capsular; arc and ventral projection of ectophallic invagination elongated (Fig. S20E), endophallus sometimes regressed or absent…………………………….……………...………..**Truljaliini** Gorochov, 2020

12. -Body not robust, pronotum as longer than wide in dorsal view. Apex of ovipositor pointed or rounded (Figs S5F, S26C). Male genitalia: MedLophi absent;

endophallus flattened dorso-ventrally (Fig. S8H) or strongly reduced (Fig. S8B), lateral margins not folded; endophallic apodeme absent………………………….……………………**Paroecanthidi** n. status…**13**

-Body robust, pronotum as wide as long or wider than long in dorsal view. Apex of ovipositor truncated (Figs S5B, H; S29C). Male genitalia: MedLophi present; endophallus not flattened, lateral margins folded (Figs S8L, S29D); endophallic apodeme generally present……**Tafaliscidi** n. status/**Tafaliscini** Desutter 1988…**14**

13. -TI tympana present. FWs covering abdomen partially or totally, stridulatory apparatus present; PCu vein curved, generally bisinuous, rarely sinuous (Fig. S3C); apical field delimited. Structures of male genitalia generally regressed, mainly from ectophallic invagination and endophallus (except *Adenophallusia* and *Ectotrypa*) (Fig. S8B)……………………….…...…….….**Paroecanthini** Gorochov, 1986…**19**

-TI tympana absent. FWs absent (Fig. S2A), only covering the metanotum (Fig. S2B) or covering the abdomen with longitudinal veins (Fig. S28A), stridulatory apparatus absent; PCu vein not curved or absent; apical field, when present, not delimited. Structures of male genitalia not regressed……………………...……………...…..**Neometrypini** Desutter 1988…**25**

Identification key to Tafaliscinae genera (adapted from Campos et al. 2020 and Campos & Desutter-Grandcolas 2020)

This key excludes the following genera that must be reviewed: *Bofana* Otte & Perez-Gelabert, 2009; *Nessa* Walker, 1869; and *Stenaphonus* Saussure, 1878. These genera have very similar features to *Angustitrella*, *Brazitrypa*, and *Tafalisca,* respectively and it is not possible to separate them in this key. Simultaneously, it is not possible to synonymize these genera because their types were not examined. *Nessa* and *Stenaphonus* are transferred to Tafaliscinae due to their morphological characteristics from the original descriptions and distribution. Both genera require revision.

14. –FWs not bearing stridulatory apparatus, sometimes with PCu vein curved and stridulatory teeth ventrally, TI tympana generally absent (present in some species of *Tafalisca*)………………………………….……….....……….……………**15**

-FWs bearing stridulatory apparatus, at least one tympanum present on TI………**17**

15. -Median ocellus absent, metanotum with projections; TI and TII without proximal protuberance; PCu vein without stridulatory teeth. Male genitalia: LLophi present, MedLophi absent…………………………………..……………..……….**16**
-Median ocellus present, metanotum generally without projections, sometimes with two median projections; TI and TII with proximal protuberance (Fig. S5N); PCu vein generally curved and sometimes with stridulatory teeth ventrally. Male genitalia: LLophi and MedLophi present (Fig. S7A, B)……***Tafalisca* Walker, 1869**

16. -Male metanotum without a central fossa. Male genitalia: PsP well-developed, almost same size of LLophi; rami curved inwards…………………..…………***Eubezverkhovia* Gorochov & Izerskyy, 2020**
-Male metanotum with a central fossa. Male genitalia: PsP short, notably shorter than LLophi; rami straight……..…………………..…***Mexitrypa* Gorochov, 2011**

17. -Pronotum with a median inverted band y-shaped dark brown or black (Fig. S30A); male metanotum without projections; TIII subapical spurs 4/3; FIII longer than TIII (Fig. S6A)…..……………...……...……………………***Perutrella* Gorochov, 2011**
-Pronotum without a median inverted band y-shaped; male metanotum with projections; TIII subapical spurs 5/4; FIII same size as TIII or slightly longer……………………………………………………………….……………..…**18**

18. -Male FWs covering the entire abdomen, stridulatory file not surrounded by strong sclerotization, apical field developed; TI with auditory tympanum on both faces; LLophi well developed, endophallic apodeme not bifid. Female apex of ovipositor without protuberances in dorsal and ventral valves.........***Amblyrhethus* Kirby, 1906**
-Male FWs not covering the entire abdomen, stridulatory file surrounded by strong sclerotization (Fig. S3D), apical field not developed; TI with auditory tympanum on outer face, inner face absent; MLophi well developed, endophallic apodeme bifid (Fig. S8M). Female apex of ovipositor with two protuberances in dorsal and ventral valves (Fig. S30B)……..***Veredatrypa* Campos, 2020**

19. -PCu vein with a sinuosity close to lateral field (Fig. S30C). Male genitalia: PsP well-developed; rami slightly longer or same-sized then pseudepiphallic sclerite; ectophallic invagination not reduced……………………………...……….……..**20**

-PCu vein bisinuous (Fig. S27B); Male genitalia: PsP regressed or absent; rami two times or longer than pseudepiphallic sclerite; ectophallic invagination generally regressed (Figs S7B, S27C) (except *Prodiatrypa* (Chopard))…………….…..…**21**

20. -Pronotum as long as wide; TI outer tympanum absent; HWs shorter than FWs; apical field absent; supra-anal plate of the male with a median projection (Fig. S30D); apex of ovipositor rounded; TIII subapical spurs 5/4. Male genitalia: apex of LLophi bifid (Fig. S30E)...***Adenophallusia* de Mello & de Camargo e Mello, 1996**

-Pronotum longer than wide; TI both tympana present; HWs longer than FWs; apical field present; supra-anal plate of the male without median projection; apex of ovipositor triangular (Fig. S30F); TIII subapical spurs 3/3, close to distal margin of TIII (some species 5/4). Male genitalia: apex o LLophi single………………………...…………..………***Ectotrypa* Saussure, 1874**

21. -Median ocellus reduced, smaller than lateral ocelli; HWs shorter or same size of FWs; apical field shorter than mirror (Fig. S30G). Male genitalia: PsP absent………..………………………………………………………………**22**

-Median ocellus not reduced or absent; HWs longer than FWs; apical field longer or same-sized than mirror (Fig. S27B). Male genitalia: PsP present, regressed…………………………….……………………………………...……..**23**

22. -TI inner and outer tympana present. Male genitalia: LLophi not finger-shaped, distal to pseudepiphallic sclerite (Fig. S30H)……………....***Selvagryllus* Otte, 2006**

-TI inner tympanum reduced or absent, outer tympanum present. Male genitalia: LLophi finger-shaped located at the base of pseudepiphallic sclerite (Fig. S30I)..***Siccotrella* Gororchov 2011**

23. -TI inner tympanum not elongated; Male genitalia: LLophi absent; ectophallic invagination and endophallic sclerite well-developed…………………………………………***Prodiatrypa* (Chopard, 1912)**

-TI inner tympanum elongated (Fig. S5I); Male genitalia: LLophi generally present; ectophallic invagination and endophallic sclerite strongly regressed (Figs. S8B, S27C)…………………………………………………………………………..…**24**

24. -Median ocellus absent; pronotum longer than wide (Fig. S27A); TI inflated, inner tympanum covered by a sclerotized tab (Fig. S5I); TIII subapical spurs 4/4. Male genitalia: LLophi absent, when present directed posteriorly (except *A. mataraku* Gorochov)…………………….…………..….***Angustitrella* Gorochov, 2011**

-Median ocellus present; pronotum wider than long or as long as wide; TI not inflated, inner tympanum not covered by a sclerotized tab; TIII subapical spurs 5/4 or 5/5. Male genitalia: LLophi generally present, directed anteriorly (Fig. S27C)…..…………………….….………...…….***Paroecanthus* Saussure, 1859**

25. -Ocelli generally present; FWs absent or brachypterous; when FWs present generally without longitudinal veins, sometimes with maximum six longitudinal veins not reticulated……………………..………………………………………**26**

-Ocelli generally absent; FWs present, covering the abdomen entirely or almost entirely, with more than six longitudinal veins reticulated……………………..…**28**

26. -FWs absent (Fig. S2A); posterior margin of pronotum covering metanotum…………………………….…..…..…….***Apterotrypa* Gorochov, 2017**

-FWs present; posterior margin of pronotum not covering metanotum ……..………………………………………..……………………………..……**27**

27. -FWs wider than long, covering only metanotum (Fig. S2B); Male genitalia: LLophi inner margin membranous (Fig. S28C)……………..…***Neometrypus* Desutter, 1988**

-FWs longer than wide, covering the two first abdominal tergites (Fig. S28B). Male genitalia: LLophi completely sclerotized…..……***Cylindrogryllus* Saussure, 1878**

28. -Body cylindrical (Fig. 18A); fastigium without tubercle; 1st abdominal tergite with projections (Fig. S4E)……………………..……………….***Brazitrypa* Gorochov, 2011**

-Body flattened dorso-ventrally; fastigium with a tubercle apically (Fig. S30J); 1st abdominal without projections………..…...….***Dicerorostrum* Gorochov, 2017**

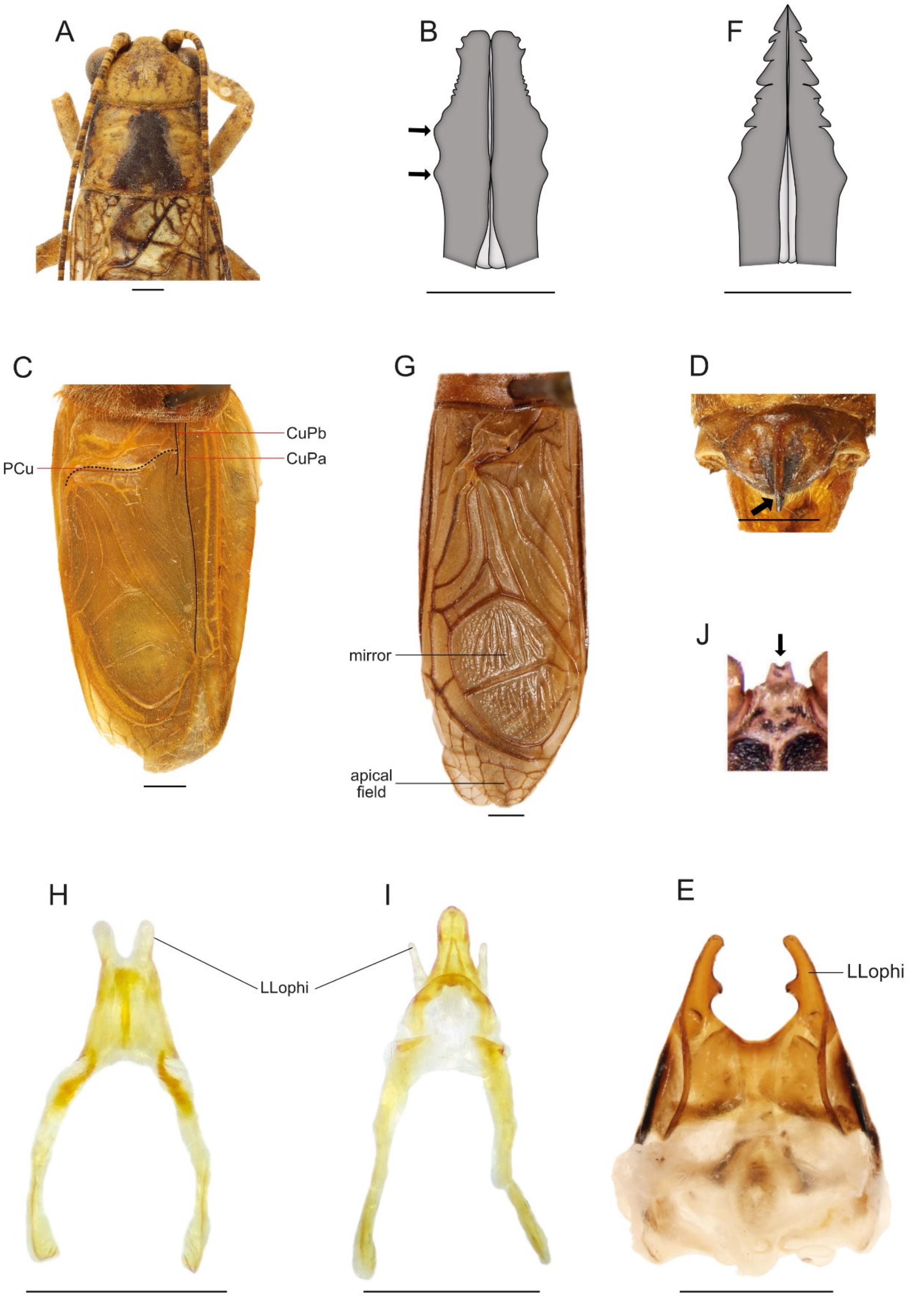


Figure S30. A-*Perutrella septentrionalis*, male, head and pronotum, dorsal view; B-*Veredatrypa rosai*, apex of ovipositor, dorsal view. *Adenophallusia legendrei*, male: C-right FW, D-supra-anal plate, E-genitalia, dorsal view. F-*Ectotrypa olmeca*, apex of ovipositor, dorsal view; G-*Siccotrella modesta*, male, right FW; H-*Selvagryllus* sp., male genitalia, dorsal view; I-*Siccotrella managua*, male genitalia, dorsal view; J-*Dicerorostrum diceros*, fastigium, dorsal view (figure from Gorochov, 2017). Scales: 1mm. Abbreviations: see material and methods.

Supporting file 1 – Convergence of MCMC analyses

Convergence assessment

Campos et al.

18/05/2021

Supplementary Material

Convergence of MCMC analyses is critical to assure that independent chains have sampled from the stationary distribution and that all parameter values have been sampled from the true posterior distribution. For that, we have inspect three runs with 90,000,000 iterations each using the R package 'Convenience' (Fabreti and Höhna 2021). The 'Convenience' package evaluates: (1) the effective sample size (ESS); (2) comparison between windows of the same run; and (3) comparison between different runs. An ESS of 625 is the default value for the convenience package (see Fabreti and Höhna 2021).

```
library(devtools)
```

```
## Loading required package: usethis
```

```
library(convenience)
```

```
## Loading required package: ape ## Loading required package: coda
```

```
## Loading required package: mcmcse
```

```
## mcmcse: Monte Carlo Standard Errors for MCMC## Version 1.4-1 created on 2020-01-29.
## copyright (c) 2012, James M. Flegal, University of California, Riverside##      John
Hughes, University of Colorado, Denver
##                          Dootika Vats, University of Warwick
##                          Ning Dai, University of Minnesota## For citation information, type
citation("mcmcse"). ##    Type help("mcmcse-package") to get started.
```

```
## Loading required package: rwty
```

```
## Loading required package: ggplot2
```

```
## Registered S3 method overwritten by 'GGally':##      method from
##    +.gg    ggplot2
```

```
## Loading required package: viridis
```

```
## Loading required package: viridisLite

## Loading required package: scales

##
## Attaching package: 'scales'

## The following object is masked from
'package:viridis':##
##       viridis_pal
```

```r
Oecanthidae <- checkConvergence("Oecanthidae/")
```

```
## Reading in log file 1
## Reading in log file 1
## Reading in log file 1
## [1] "Calculating burn-in"
## [1] "Analyzing continuous parameters"
```

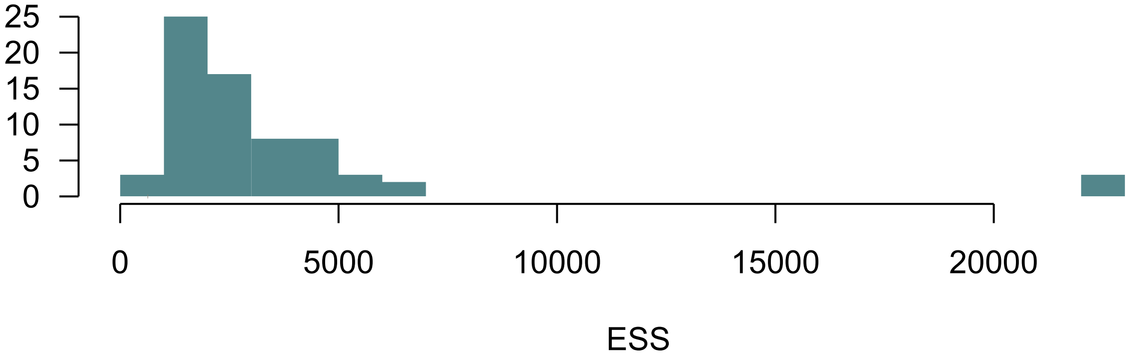
```r
# the paste includes four log files from independent runs generated by divergence time
estimation using

Oecanthidae # summary information
```

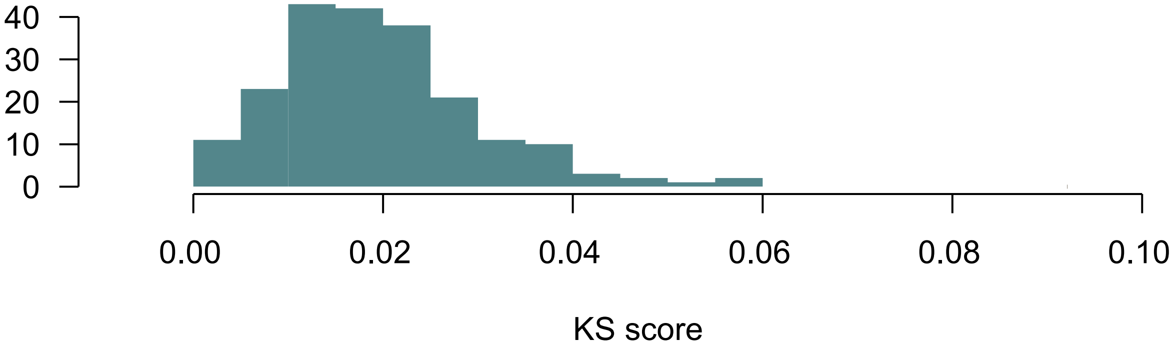
```
##   ACHIEVED CONVERGENCE
##
##   BURN-IN SET AT
0##
##   LOWEST CONTINUOUS PARAMETER ESS
##          RUN 1 -> mrca.date.backward.Gryllidae. 1002.57
##          RUN 2 -> mutationRate.12s 659.64
##          RUN 3 -> rate.coefficientOfVariation 651.15
##
##   To check the calculated parameters for the continuous parameters
type:##        Means: output$continuous_parameters$means
##          ESS: output$continuous_parameters$ess
##          KS score:
output$continuous_parameters$compare_runs##
```

```r
Oecanthidae$converged # Have the runs achieved convergence?
```

```
## [1] TRUE
```

```r
# Diagnostic plots
par(mfrow = c(2,1))
plotEssContinuous(Oecanthidae) # ESS for continuous parameters
plotKS(Oecanthidae) # KS statistic
```


Histogram of ESS for continuous parameters


KS histogram

```
# In both histograms the thresholds are indicated by dotted lines.
```

Convergence of MCMC runs was achieved. Therefore, all parameters values were estimated from the stationary distribution.

Supporting file 2 – Results of ML and MP analyses

ML phylogeny

Oecanthidae n. status is well supported (98 UB/88 B) and its four subfamilies. Euscyrtinae (100 UB/B), Oecanthinae (99 UB/83 B), Podoscirtinae (100 UB/99 B), and Tafaliscinae (100 UB/B) (Fig. S13). Oecanthinae is divided into two supertribes, Diatrypidi n. status(100UB/B) and Oecanthidi n. status (100UB/B). Oecanthidi n. status is composed of two tribes, Oecanthini Blanchard, 1845 (100UB/B) and Xabeini Vickery & Kevan, 1983 (100 UB/B) (Table 3, Fig. S13). Podoscirtinae is the sister-group of Oecanthinae divided into two supertribes, Hapithidi n. status (100 UB/B) and Podoscirtidi n. status (100 UB/B). Hapithidi n. status has four tribes: Aphonomorphini Desutter, 1988 (100 UB/B), Cearacesaini Koçak & Kemal, 2010 (100 UB/B), Hapithini Gorochov, 1986 (99 UB/ 98 B), and Phyllogryllini n. tribe (99 UB/ 98 B) (Table 3, Fig. S13). In Podoscirtidi n. status, the tribe Aphonoidini Gorochov, 2008 appears as a monophyletic group with three taxa (*Munda aff. asyrinx*, *Mistchenkoana* sp., and a possible new genus). Podoscirtini resulted in a monophyletic tribe (100/86), including the genera *Fryerius*, *Calscirtus*, *Matuanus*, *Pixipterus*, *Adenopterus*, and *Archenopterus*. Truljaliini n. status (100/100) appears as the sister clade of all other Podoscirtidi. *Prozvenella bangaloriens* appears as *incertae sedis*, without a tribe to be placed.

Tafaliscinae is recovered as monophyletic divided into two supertribes, Tafaliscidi n. status (100 UB/B) and Paroecanthidi n. status (100 UB/ 96 B). Tafaliscidi is composed only by a single tribe, Tafaliscini. Paroecanthidi is composed by Neometrypini Desutter, 1988 (100 UB/B) and Paroecanthini Gorochov, 1986 (76 UB / 49B). Paraoecanthini has low support than other clades, possibly due to the missing data of *Adenophallusia legendrei* (Table 1).

MP phylogeny

The MP analysis obtained four most parsimonious trees with 13,684 steps, ci 0.23 and ri 0.59. A strict consensus tree was obtained with supports B and JK represented in the nodes (Fig. S14). Unlike ML and divergence times analyses, some support values are low for Oecanthidae and the relationship between subfamilies. Models are not typical and accurate in MP analysis. Probably this is the cause of the low support of some nodes. However, the subfamilies and supertribes' support values are strong except for Oecanthinae (37 JK/ 34 B).

The difference between MP topology and ML topology is that three taxa positions do not interfere with the monophyletism of subfamilies, supertribes, and tribes. In Diatrypidi, the terminal Diatrypini Black (probably a new genus) is the sister of *D.* (*Latispeculum*) species in MP analysis. In contrast, it is the sister of all taxa of Diatrypidi in ML. Inside Oecanthini clade, *Oecanthus chorpadi* is the sister of all *Oecanthus* species in MP and switches places with *Oecanthus* sp. from Comores in ML. A similar situation happens in the Tafaliscidi clade. *Perutrella septentrion*alis is sister to all Tafaliscidi taxa in MP. In ML, *P. septentrionalis* is siter of the genus *Tafalisca*.

Capítulo 2

Are oecanthid crickets stop singing? The history of characters related to acoustic communication in Oecanthidae (Insecta, Orthoptera, Grylloidea)

Abstract

True crickets are frequently used as models in many areas of science as acoustic communication, behavior, ecology, and neurobiology. However, only a few studies are focused on a phylogenetic context since the number of proposed phylogenies for this group is low. The acoustic communication of these insects is considered an essential element of their evolution. It is a subject constantly debated, but only a few works are in a phylogenetic frame. Here we use the phylogeny of Oecanthidae, based on molecular and morphological characters, to reconstruct the history of characters related to acoustic communication as forewings, its structures, and tympana. In total, the history of six characters are analyzed. Our results demonstrate that the independent loss of acoustic communication characters along the time occurred for multiple oecanthid taxa. Consequently, several of these taxa are not able to use forewings to stridulate. We discuss the potential causes of losing the capacity of sound-producing and hearing and their alternatives for efficient communication not exclusively based on sounds.

Keywords: tree crickets, evolution, ancestral state reconstruction, forewings

Introduction

Crickets (Orthoptera: Grylloidea) are among the first musicians on Earth and belong to the nocturnal acoustic landscape for at least 200 million years (Nel, 2021). The sound produced by the males of these insects is mainly related to the reproductive behavior with calling (the most frequent and standard), courtship, copulate, and post-copulate songs (the last two less common) (Alexander, 1962; Huber *et al.*, 1989). However, crickets' songs are more than male-female interactions. They are also functional for parental care, territoriality, and aggressiveness (Huber *et al.*, 1989). The sound generated by each species is different from the others in the same space and time, and even though they communicate intraspecifically, they also communicate interspecifically to avoid predators and parasitoids (Cade, 1975; Cade and Rice, 1980).

Crickets are among the most studied organisms in bioacoustics. The sound production mechanism in Grylloidea have been studied for over 50 years and is well understood in the scientific environment, at least for some common species. In most crickets, both tegmina are symmetrical and, in adult males, show a modified vein, the stridulatory vein (Post-Cubital vein (PCu) (Desutter-Grandcolas *et al.*, 2017; Schubnel *et al.*, 2019), with tiny chitinous teeth ventrally (Fig. 1A1, 2), and a highly sclerotized region along inner margin, called the plectrum (Elliott and Koch, 1983; Koch *et al.*, 1988; Montealegre-Z *et al.*, 2009). At rest, the right forewing (FW) is always above the left FW in adult males (it is the reverse in katydids), considered a synapomorphy of Grylloidea.

To sing, a male cricket raises its FWs above its dorsum, and regularly opens and closes its FWs: the plectrum of the left FW then scrapes on the ventral teeth file of the stridulatory vein during the closing, producing the mechanical vibrations that generate the sound (Elliott and Koch, 1983, 1985; Montealegre-Z *et al.*, 2009). Moreover, FWs have resonators in different regions, responsible for amplifying the originated mechanical waves. Those resonators are FWs cells called the harp (composed of the harp veins) and to a lesser extent the mirror (Nocke 1971; Bennet-Clark, 2003) (Fig. 1G, H). This set of structures involved in sound production is known as the stridulatory apparatus (SA) (Desutter-Grandcolas, 1997a, 1998a, 2003; Béthoux, 2012; Schneider *et al.*, 2018). Although the sound production mechanism is well-established in crickets, the understanding of the origin and evolution of these structures is in constant debate in the scientific community.

It is a consensus that SA structures originated only once in Grylloidea (Gwynne, 1995; Desutter-Grandcolas, 2003; Desutter-Grandcolas *et al.*, 2017; Song *et al.*, 2020), and that several diversification events of the FWs occurred a posteriori during cricket evolution, including regression and loss (Desutter-Grandcolas, 1997a; Robillard and Desutter-Grandcolas, 2004). Several selective forces can be responsible for the loss of acoustic communication in crickets. The most commonly accepted is predation (Walker, 1964; Cade, 1975; Otte, 1990, 1992; Desutter-Grandcolas, 1998a, 2003; Desutter-Grandcolas *et al.*, 2017). From there, it has been hypothesized that the loss or the resurgence of the acoustic communication in crickets could be related to periods of the evolutionary history of more or less intense predation, respectively (Desutter-Grandcolas *et al.*, 2017). Other factors could be related to the modification or diversification of acoustic communication in crickets, like the conquest of habitats not favorable to sound propagation, the development of another type of communication, and population structure (Alexander, 1962; Otte, 1990, 1992; Römer *et al.*, 1993).

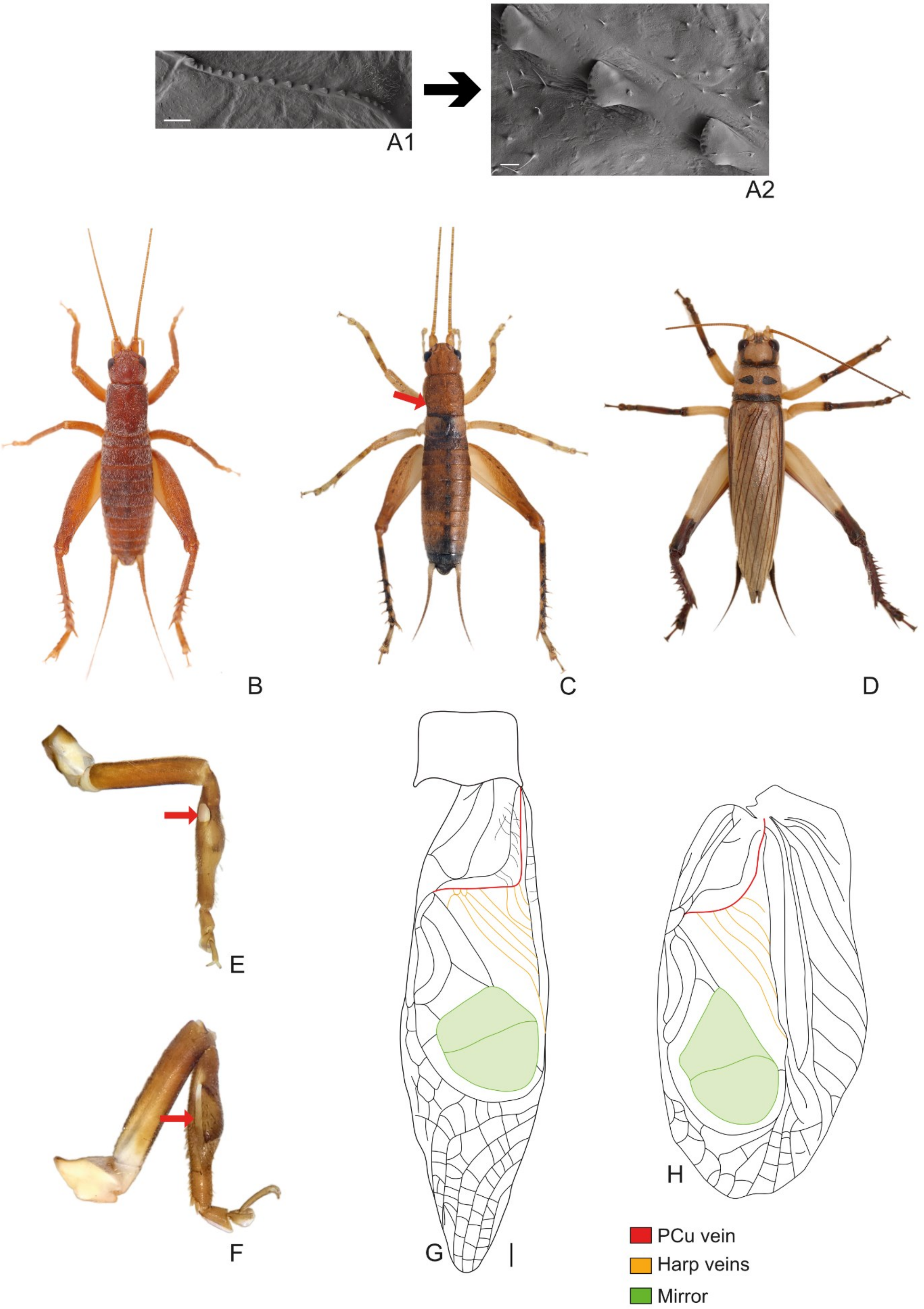


Figure 1. A-*Diatrypa* (*Diatrypa*) *tuberculata*: 1-PCu vein ventral view, 2-teeth of PCu vein. B-*Neometrypus couriae*, male C-Neometrypus catiae, male; D-*Tafalisca elongata*, male. *Angustitrella mataraku*, fore tibia: E-outer face, F-inner face. G-*Truljalia hibinonis*, right forewing; H-*Diatrypa* (*Diatrypa*) *tuberculata*, right forewing. Scales: A1-100 µm, A3-10 µm, G-1mm.

Acoustic communication in crickets has been the subject of several studies over the years, raising many questions in different fields of knowledge like evolution, behavior, and biophysics (e.g. Alexander, 1962; Huber *et al.*, 1989; Desutter-Grandcolas, 1997; Bennet-Clark, 2003; Robillard and Desutter-grandcolas, 2011). Furthermore, forewings and acoustic communication in Grylloidea are intrinsically connected and have been significant sources of information for taxonomy and phylogenetic analysis (Gwynne, 1995; Desutter-Grandcolas, 1997; Desutter-Grandcolas and Robillard, 2004; Robillard and Desutter-Grandcolas, 2004; Jost and Shaw, 2006; Robillard and Desutter-Grandcolas, 2011, Campos *et al.*, submitted). Besides their importance in the history of crickets, only a few studies used a phylogenetic approach to understand their evolution (Desutter-Grandcolas and Robillard, 2004; Vicente *et al.*, 2017; Dong *et al.*, 2018; Campos *et al.*, 2021; Tan *et al.*, 2021). With the study of their phylogeny (Campos *et al.*, submitted), Oecanthidae is an additional model to test hypotheses of FW evolution of crickets, especially because they present a very high diversity of characters and behaviors related to FWs. Their study gives the possibility of comprehending another piece of a highly diverse clade of Grylloidea, where FWs and acoustic communication are a principal source of information in this group (Campos *et al*., submitted).

Oecanthidae is a diverse family of crickets distributed worldwide (except poles) with ~1,400 species, which lineages started to diversify about 130 million years ago (Cigliano *et al.*, 2022, Campos *et al*., submitted). This monophyletic and well-supported lineage of Grylloidea is composed of insects generally living in plants like grasses, bushes, and trees. Morphologically, the group is recognized by the inner apical spurs of the hind tibia three times longer or more than the outer ones; fore and mid legs' first and second tarsomeres same-sized with pulvillum, the second flattened dorso-ventrally; ovipositor apex generally with projections and lateral margins serrulated (Campos *et al*., submitted). Besides their similarities, this group exhibits a remarkable diversity of body size, general morphology, and mainly FWs (Otte and Alexander, 1983; Otte, 1994; Otte and Pérez-Gelabert, 2009; Gorochov, 2017; Campos and Desutter-Grandcolas, 2020, Campos *et al*., submitted). The diversity of this lineage is represented by crickets with developed FWs, reduced (brachypterous) or apterous; when FWs are present, crickets with or without SA, or with or without specific components of the SA. All these different conditions indicate a huge diversity of communication modalities (Campos and Desutter-Grandcolas, 2020). Because of the variability observed for auditory tympana (presence, absence, shape, and development), it can be hypothesized that at least for part of this clade communication may have evolved in a non-acoustic frame.

This paper aims to explore the historical diversification of oecanthid communication modalities, by studying the characters describing FWs morphology and auditory tympana through the ancestral state reconstruction methodology, using the reference phylogeny built for this very diverse clade of crickets (see Chapter 1).

Material and Methods

Phylogenetic tree and taxon sampling

To investigate the evolution of the characters related to acoustic communication in Oecanthidae, 107 terminals of the topology based on molecular and morphological data using maximum likelihood (ML) as optimality criteria were examined (see chapter 1). The molecular data comprises four molecular markers: two mitochondrial, rDNA 12s, and rDNA 16s; two nuclear, rDNA 18s, and two sub-unities of rDNA 28s (A and D). The morphological matrix comprises characters from adult males and females, including wings and genitalia (for details of the characters, see Chapter 1). The phylogenetic hypothesis shows Oecanthidae as a monophyletic group divided into four subfamilies:

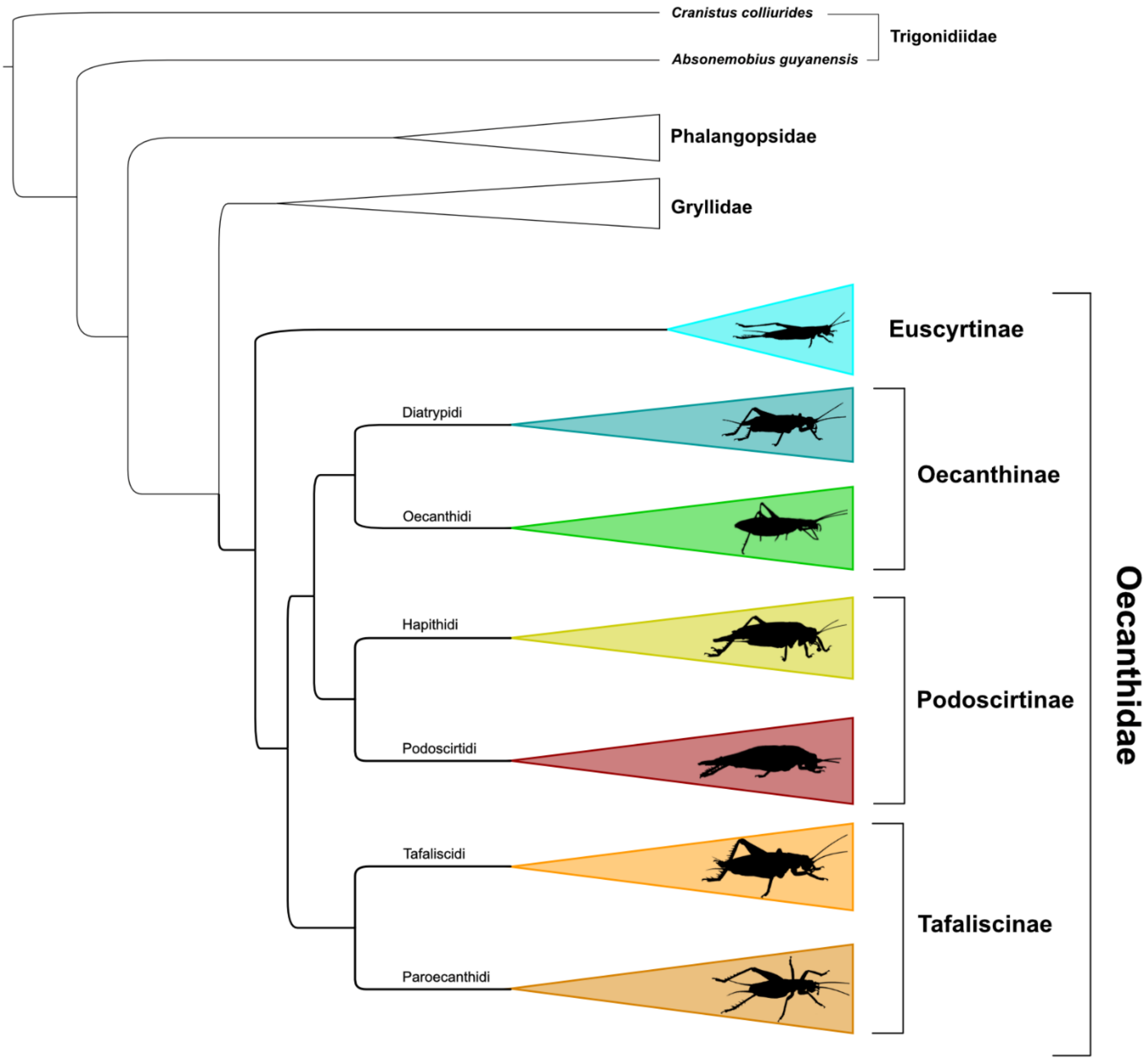


Figure 2. Oecanthidae consensus tree of maximum likelihood, parsimony, and bayesian inference analyses from Campos *et al.* submitted indicating its subfamilies and supertribes.

Euscyrtinae Gorochov, 1985; Oecanthinae Blanchard, 1845; Podoscirtinae Saussure, 1878; and Tafaliscinae Desutter, 1988 (Fig. 2). The entire classification proposed in Campos *et al*. submitted is summarized in table 1.

Table 1. Classification of Oecanthidae based on the ML, MP, and BI resulting tree of chapter 1.

Family	Subfamily	Supertribe	Tribe
Oecanthidae	Euscyrtinae		
	Oecanthinae	Oeacanthidi	Oecanthini
			Xabeini
		Diatrypidi	Diatrypini
	Podoscirtinae	Podoscirtidi	Aphonoidini
			Podoscirtini
			Truljaliini
		Hapithidi	Hapithini
			Aphonomorphini
			Cearacesaini
			Phyllogryllini
	Tafaliscinae	Tafaliscidi	Tafaliscini
		Paroecanthidi	Paroecanthini
			Neometrypini

The examined material belongs to the following institutions: Laboratório de Insetos do Departamento de Zoologia da UNESP de Botucatu, Botucatu, Brazil (BOTU), Muséum national d'Histoire naturelle, Paris, France (MNHN), Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZSP), Instituto Nacional de Pesquisas da Amazônia Manaus, Brazil (INPA). The examined specimens are in Table 2.

Table 2. Examined material, with repositor institutions and collecting sites.

Taxon	Subfamily	Repository	Locality
Absonemobius guyanensis	Nemobiinae	MNHN	French Guiana
Cranistus colliurides	Trigonidiinae	MZSP	Brazil, Itatiaia
Aracamby sp. Cantareira	Luzarinae	MZSP	Brazil, São Paulo
Eidmanacris endophallica	Luzarinae	MZSP	Brazil, Serra dos Orgãos
Endecous sp. Cantareira	Luzarinae	MZSP	Brazil, São Paulo
Cardiodactylus novaeguineae	Eneopterinae	MNHN	Vanuatu, Espiritu Santo
Eneoptera surinamensis	Eneopterinae	MZSP	Brazil, Camacan
Ligypterus linharensis	Eneopterinae	MZSP	Brazil, Camacan
Xenogryllus eneopteroides	Eneopterinae	MNHN	Central African Republic
Anurogryllus sp. Itatiaia	Gryllinae	MZSP	Brazil, Itatiaia
Eumodicogryllus bordigalensis	Gryllinae	MNHN	The Netherlands
Gryllodes sigillatus	Gryllinae	MNHN	Comoros, Anjouan
Gryllus sp. Veredas	Gryllinae	MZSP	Brazil, Veredas
Zebragryllus nouragui	Gryllinae	MNHN	French Guiana, Arataye
Creolandreva crepitans	Landrevinae	MNHN	Mauritius
Odontogryllus setosus	Landrevinae	MNHN	French Guiana, Arataye
Xulavuna n.sp.	Landrevinae	MZSP	Brazil, Contraguaçu
Euscyrtus aff. bipunctatus	Euscyrtinae	MNHN	Vanuatu, Espiritu Santo
Euscyrtus bivittatus	Euscyrtinae	MNHN	Mauritius
Proturana subapterus	Euscyrtinae	MNHN	New Caledonia
Diatrypa (Diatrypa) sp. Sta.Teresa	Oecanthinae	MZSP	Brazil, Santa Teresa
Diatrypa (Diatrypa) tuberculata	Oecanthinae	MZSP	Brazil, Itatiaia
Diatrypa (Latispeculum) sp. Manaus	Oecanthinae	INPA	Brazil, Manaus
Diatrypa (Latispeculum) aff. brunnea	Oecanthinae	MZSP	Brazil, Jau
Diatrypini Black n. gen?	Oecanthinae	MZSP	Brazil, Igrapiúna
Neoxabea brevipes	Oecanthinae	MZSP	Brazil, Salesópolis
Neoxabea sp. GUY	Oecanthinae	MNHN	French Guiana, Arataye
Oecanthus chopardi	Oecanthinae	MNHN	Yemen, Socotra
Oecanthus lineolatus	Oecanthinae	MZSP	Brazil, São Lourenço do Sul
Oecanthus pallidus	Oecanthinae	MZSP	Brazil, Botucatu
Oecanthus sp. BRA	Oecanthinae	MNHN	Brazil, Linhares
Oecanthus sp. COM	Oecanthinae	MNHN	Comoros, Anjouan
Prognathogryllus pihea	Oecanthinae	MNHN	Hawaii
Thaumatogryllus variegatus	Oecanthinae	MNHN	Hawaii
Adenopterus sp.1	Podoscirtinae	MNHN	New Caledonia
Adenopterus sp.2	Podoscirtinae	MNHN	New Caledonia
A. (Aphonomorphus) aff. montanus Jau	Podoscirtinae	MZSP	Brazil, Jau
Archenopterus adamantus	Podoscirtinae	MNHN	New Caledonia
Archenopterus sp.	Podoscirtinae	MNHN	New Caledonia
Archenopterus sp. NCAL	Podoscirtinae	MNHN	New Caledonia
Calscirtus amoa	Podoscirtinae	MNHN	New Caledonia
Calscirtus sp.	Podoscirtinae	MNHN	New Caledonia
Cearacesa cearensis	Podoscirtinae	MZSP	Brazil, Porto Seguro
Cearacesa nova	Podoscirtinae	MZSP	Brazil, Gameleira do Assuará
Euaphonus sp. GUY	Podoscirtinae	MNHN	French Guiana, Arataye
Freyrius sp. COM	Podoscirtinae	MNHN	Comoros, Anjouan
Gryllophyllus sp. GDP	Podoscirtinae	MNHN	Guadeloupe
Hapithus sp. MEX	Podoscirtinae	MNHN	Mexico, Chiapas

Table 2. Examined material, with repositor institutions and collecting sites. Continued.

Taxon	Subfamily	Repository	Locality
Matuanus aff. mirabilis	Podoscirtinae	MNHN	New Caledonia
Mistchenkoana sp. Santo	Podoscirtinae	MNHN	Vanuatu, Espiritu Santo
Munda aff. asyrinx	Podoscirtinae	MNHN	Indonesia, Java
Phyllogryllus pipilans	Podoscirtinae	MNHN	French Guiana, Papaichton
Phyllogryllus sp. Veredas	Podoscirtinae	MZSP	Brazil, Veredas
Phyllogryllus velutinus	Podoscirtinae	MZSP	Brazil, Belterra
Pixipterus sp. NCAL	Podoscirtinae	MNHN	New Caledonia
POD n. gen.? Santo	Podoscirtinae	MNHN	Vanuatu, Espiritu Santo
Podo *Archenopterus*	Podoscirtinae	MNHN	New Caledonia
Prozvenella bangalorensis	Podoscirtinae	MNHN	India, Karnataka
Somnambula livida	Podoscirtinae	MNHN	French Guiana, Saint-Jean-du-Maroni
Somnambula ucayali	Podoscirtinae	MZSP	Brazil, Manaus
Sonotrella (Calyptotrella) bispinosa	Podoscirtinae	MNHN	Indonesia
Stenogryllus sp. GDP	Podoscirtinae	MNHN	Guadeloupe
Stenogryllus sp. MGA	Podoscirtinae	MNHN	Marie-Galante
Taroba elephantina	Podoscirtinae	MZSP	Brazil, Foz do Iguaçu
Truljalia hibinonis	Podoscirtinae	MNHN	China, Padang
Adenophallusia legendrei	Tafaliscinae	MNHN	French Guiana, Mitaraka
aff. Cylindrogryllus Belterra	Tafaliscinae	MZSP	Brazil, Belterra
Amblyrhethus n.sp.1 Chap.Gui.	Tafaliscinae	BOTU	Brazil, Chapada dos Guimarães
Amblyrhethus n.sp.2 Linhares	Tafaliscinae	BOTU	Brazil, Linhares
Amblyrhethus sp. Alagoas	Tafaliscinae	BOTU	Brazil, Satuba
Angistitrella vicina 1	Tafaliscinae	MNHN	French Guiana, Mitaraka
Angustitrella aff. *vicina* 1 GUY	Tafaliscinae	MNHN	French Guiana, Nouragues
Angustitrella mataraku	Tafaliscinae	MZSP	Brazil, Porto Velho
Angustitrella picipes	Tafaliscinae	BOTU	Brazil, Linhares
Angustitrella sp. Guy	Tafaliscinae	MNHN	French Guiana, Arataye
Angustitrella sp. Guy	Tafaliscinae	MNHN	French Guiana, Papaichton
Angustitrella sp. Manaus	Tafaliscinae	INPA	Brazil, Manaus
Angustitrella vicina 2	Tafaliscinae	MNHN	French Guiana, Mitaraka
Apterotrypa mitarakensis	Tafaliscinae	MNHN	French Guiana, Mitaraka
Apterotrypa n.sp.1 Foz	Tafaliscinae	MZSP	Brazil, Foz do Iguaçu
Apterotrypa n.sp.2 Jau	Tafaliscinae	MZSP	Brazil, Jau
Apterotrypa n.sp.3 Cariacica	Tafaliscinae	MZSP	Brazil, Cariacica
Apterotrypa n.sp.4 GUY	Tafaliscinae	MNHN	French Guiana, Nouragues
Brazitrypa longiapex	Tafaliscinae	MZSP	Brazil, Santa Teresa
Brazitrypa n.sp. Foz	Tafaliscinae	MZSP	Brazil, Foz do Iguaçu
Brazitrypa paranaensis	Tafaliscinae	MZSP	Brazil, Foz do Iguaçu
Brazitrypa paulista	Tafaliscinae	MZSP	Brazil, Salesópolis
Brazitrypa sp. BRA	Tafaliscinae	MNHN	Brazil, Santa Lucia
Cylindrogryllus pitanga	Tafaliscinae	MZSP	Brazil, Ilhéus
Neometrypus badius	Tafaliscinae	BOTU	Brazil, Cariacica
Neometrypus n.sp. Boraceia	Tafaliscinae	MZSP	Brazil, Salesópolis
Neometrypus n.sp.1 Itatiaia	Tafaliscinae	MZSP	Brazil, Itatiaia
Neometrypus n.sp.2 Itatiaia	Tafaliscinae	MZSP	Brazil, Itatiaia
Neometrypus sp. BRA	Tafaliscinae	MNHN	Brazil, Linhares
Perutrella septentrionalis	Tafaliscinae	MNHN	French Guiana
Tafalisca aff. elongata	Tafaliscinae	MZSP	Brazil, Belterra

Table 2. Examined material, with repositor institutions and collecting sites. Continued.

Taxon	Subfamily	Repository	Locality
Tafalisca ansoi	Tafaliscinae	MNHN	French Guiana, Papaichton
Tafalisca bahiensis	Tafaliscinae	BOTU	Brazil, Itamaraju
Tafalisca duckeana	Tafaliscinae	MNHN	Brazil, Manaus
Tafalisca elongata elongata	Tafaliscinae	MNHN	French Guiana, Mitaraka
Tafalisca hugeli	Tafaliscinae	MNHN	French Guiana, Mitaraka
Tafalisca n.sp.2 GDP1	Tafaliscinae	MNHN	Guadeloupe
Tafalisca n.sp.2 GDP2	Tafaliscinae	MNHN	Guadeloupe
Tafalisca sp. Jau	Tafaliscinae	MZSP	Brazil, Jau
Tafalisca vestigialis	Tafaliscinae	MZSP	Brazil, Belterra
Veredatrypa rosai	Tafaliscinae	MZSP	Brazil, Veredas
Veredatrypa seca	Tafaliscinae	MZSP	Brazil, Ubajara

Morphological data

Characters were examined under stereomicroscope Zeiss Stemi DV4 and Wild M3Z. The morphological terminology adopted for general morphology and forewings follows Desutter (1987), Desutter-Grandcolas (2003), and Desutter-Grandcolas *et al.,* (2017) modified by Schubnel *et al.,* (2019). Drawings were made under Leica MZ9.5 and Wild M3Z stereomicroscopes coupled with camera lucida. The photographs were taken with Leica DFC-420 camera through Leica MZ16 stereomicroscope and a Canon 60D with macro lenses of 100 mm and 65 mm 1-5x coupled using software Helicon Remote. The photographs were edited with Affinity Photo. Plates were made, and drawings were digitalized with Affinity Designer.

Five morphological characters (Fig. 1) related to acoustic communication were investigated (four binary, one multistate). The data matrix was constructed on Mesquite 3.61 (Maddison and Maddison, 2021). The characters and their states are in table 3. The data matrix is in the supporting information (Table S1).

Table 3. Investigated characters related to acoustic communication and its states.

Character	State 0	State 1	State 2
Inner tympanum	Absent	Present (Fig. 1F)	
Outer tympanum	Absent	Present (Fig. 1E)	
Forewings (FWs)	Absent (Fig. 1B)	Brachypterous (Fig. 1C)	Developed (Fig. 1D)
Stridulatory File	Absent (Fig. 1B-D)	Present (Fig. 1G, 2H)	
Harp veins (hv)	Absent (Fig. 1B-D)	Present (Fig. 1G, 2H)	
Mirror	Absent (Fig. 1B-D)	Present (Fig. 1G, 2H)	

Character Evolution

To investigate acoustic communication and forewing (FW) evolution we carried out ancestral state reconstructions under ML approach in Mesquite 3.61 (Maddison and Maddison, 2021) over the ML tree obtained in Campos *et al.*, submitted. Likelihood Ratio Test (LRT) (Pagel, 1998; Maddison and Maddison, 2021) were applied to decide if using symmetrical ($0 \rightarrow 1 = 1 \leftarrow 0$) or asymmetrical ($0 \rightarrow 1 \neq 1 \leftarrow 0$) transition rates models. The symmetrical model MK1 for all six characters proposed was selected, which assumes the same rate for all transitions (*P*-value > 0.05) (Table 4). The character, forewings, has three states: absent (0), brachypterous (1), or developed (2). Thus, it is not possible to calculate asymmetrical transitions and consequently the LRT in this case.

Table 4. Likelihood ratio test between symmetrical and asymmetrical transition rates. Significant *P*-value <0.05 for choosing asymmetrical transitions. States of inner tympanum, outer tympanum, stridulatory file, harp veins, and mirror are absent (0) or present (1). Forewings states are absent (0), brachypterous (1), or developed (2).

	Inner tympanum	**Outer tympanum**	**Forewings**	**Stridulatory file**	**Harp veins**	**Mirror**
Symmetrical (MK1)						
-log L	47.7478	42.4802	44.9310	46.8637	42.5744	47.3464
trans. rate (0↔1)	2.4281	1.9678	0.7268	2.0519	1.8382	2.0198
Asymmetrical (2 parameters)						
-log L	47.2828	47.2828	-	45.6345	41.6037	46.9631
forward rate (0→1)	3.4881	3.4881	-	0.6276	0.7708	1.2289
backward rate (0←1)	1.8368	1.8368	-	2.2392	2.1394	2.2831
Likelihood ratio	0.93	1.4054	-	2.4582	1.9413	0.7665
***P*-value**	**0.3349**	**0.2358**	-	**0.1169**	**0.1635**	**0.3813**

The origin of tympana in Ensifera is previous to acoustic communication development (Desutter-Grandcolas, 2003), in Gryllidea, acoustic apparatus and tympana appeared at the same node in phylogeny, supporting the hypothesis that hearing appeared in crickets in the frame of intraspecific acoustic communication (Desutter-Grandcolas, 2003). Other authors consider that tympana appeared for detecting predators, but this hypothesis was proposed without a phylogenetic frame and topology (Otte, 1990). However, modifications on sound-producing systems could induce auditive system changes and vice versa (Huber *et al.*, 1989). The tympanum present on the forelegs is the main responsible for hearing in crickets. Here, inner and outer tympanum are considered independent characters. The absence of both tympana indicates the impossibility of hearing sounds, although there remains the possibility to perceive the vibration generated by the sounds at least with the legs (this has not been considered here, as the sensory equipment involved here exists in all insects: it would in fact be necessary to study the recognition of the perceived sounds by the nervous system, i.e. a whole domain of research per se: see (Yack *et al.*, 2020). The thoracic structures on the first stigmata, and their connections to trachea, was not considered.

The forewings, and consequently, the stridulatory file, play the most crucial role in sound production in crickets. In true crickets, the forewings, also known as tegmina, are not responsible for the flight. Only the hindwings are. But, the forewings are essential for protection, mimicry, and acoustic communication in crickets with veins adapted for sound production; FWs may also bear glandular organs involved in mating.

Results

Tympana

The ancestral state reconstructions showed a high probability of having both inner (82%) and outer tympana (92%) as the ancestral condition of Oecanthidae. And later the inner tympanum was lost at least six times during the evolution of oecanthids: in whole Euscyrtinae (85%), in the Hawaiian *Thaumatogryllus variegatus* (Oecanthinae, Oecanthidi, Xabeini), in the neotropical *Taroba elephantina* (Podoscirtinae, Hapithidi, Cearaceasaini), in the New Caledonian *Pixipterus* sp. (Podoscirtinae, Podoscirtidi, Podoscirtini), in the neotropical Neometrypini (Tafaliscinae, Paroecanthidi) (96%), and in the neotropical Tafaliscidi (Tafaliscinae) (52% absent), although reappeared in a *Tafalisca* species from Brazilian Amazon, and in the genera *Amblyrhethus* and *Perutrella* (Fig. 3). On the other hand, the outer tympanum was lost at least seven times: in whole Euscyrtinae (86%), in neotropical Cearacesaini (Podoscirtinae, Hapithidi) (91%), in neotropical Aphonomorphini (Podoscirtinae, Hapithidi) (83%), in *Mistchenkoana* sp. and in a possibly new genus from Vanuatu (Podoscirtinae, Podoscirtidi, Aphonoidini) (97%), in the neotropical *Tafalisca* (Tafaliscinae, Tafaliscidi), *Adenophallusia* (Tafaliscinae, Paroecanthidi, Paroecanthini), and Neometrypini (Tafaliscinae, Paroecanthidi) (97%) (Fig. 3).

The taxa that lost both outer and inner tympana and consequently the capacity of hearing were: Euscyrtinae (both tympana recovered in *Euscyrtus bivitattus*), *Thaumatogryllus variegatus*, *Taroba elephantina*, *Pixipterus* sp., the genus *Tafalisca* (recovered in a Brazilian Amazon species), and Neometrypini (Fig. 3).

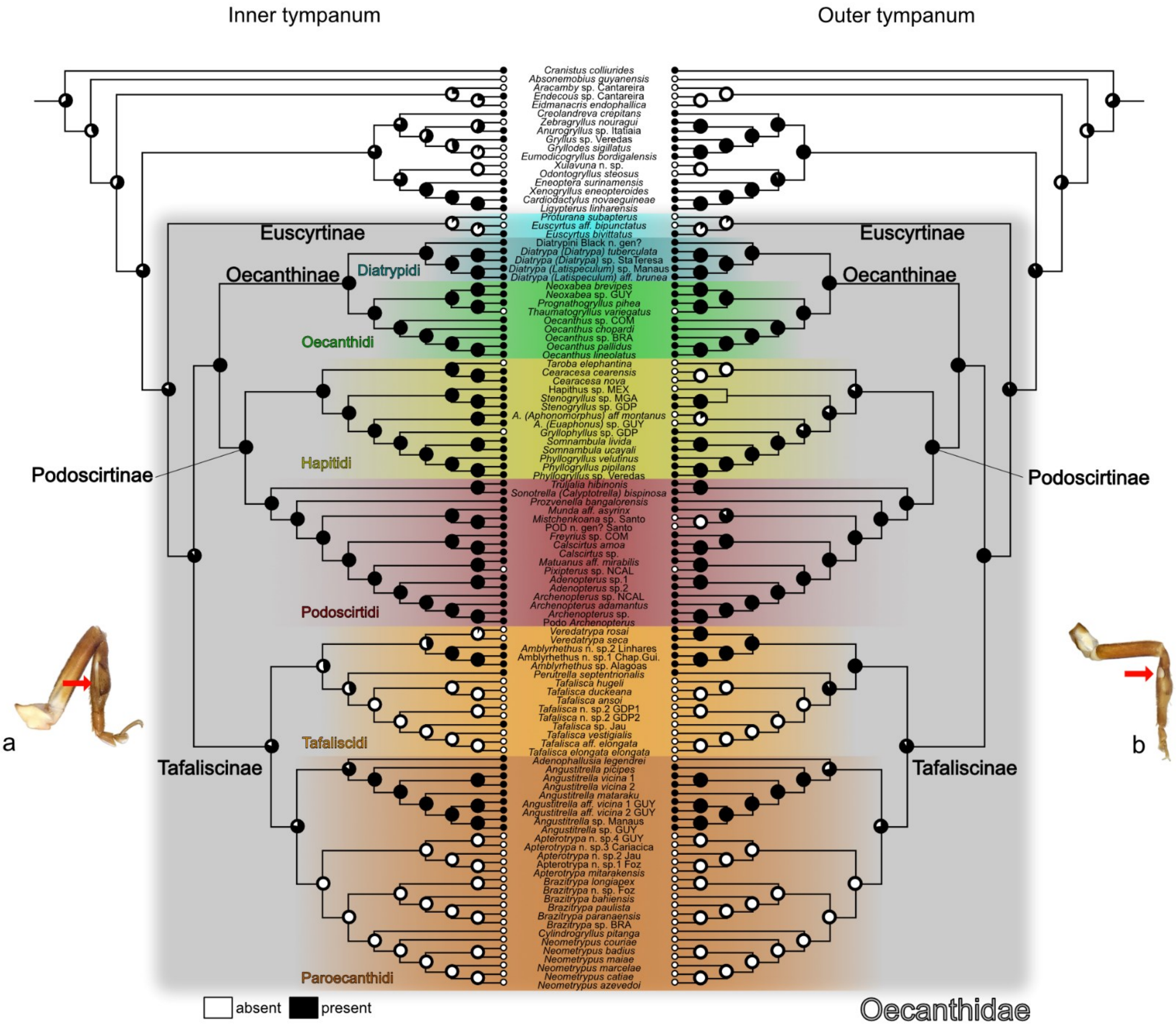


Figure 3. Ancestral state reconstruction of inner tympanum (left) and outer tympanum (right) in Oecanthidae under maximum likelihood approach with equal rates (MK1). *Angustitrella mataraku* fore tibia: a-outer face, b-inner face.

Forewings

The ancestral of Oecanthidae had developed FWs and later modified for brachyptery at least four times: in Euscyrtinae, *Thaumatogryllus variegatus* (Oecanthinae), *Taroba elephantina* (Podoscirtinae), and *Cylindrogryllus* + *Neometrypus* (78%). The FWs were lost only twice within Tafaliscinae: in the genus *Apterotrypa* and in *Neometrypus couriae* (Paroecanthidi, Neometrypini) (Fig. 4).

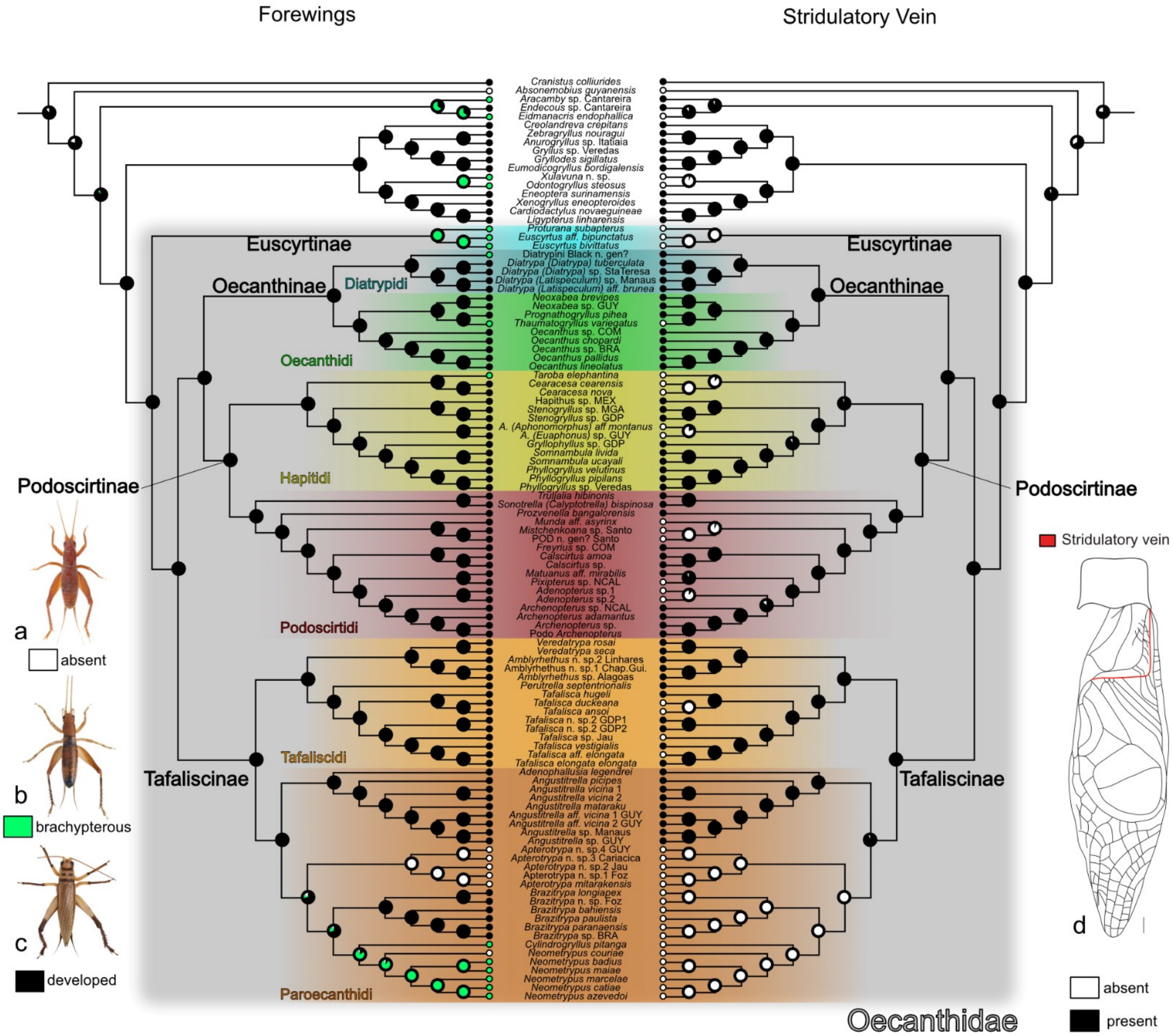


Figure 4. Ancestral state reconstruction of forewings development (left) and stridulatory vein (PCu vein) in Oecanthidae under maximum likelihood approach with equal rates (MK1). a-*Neometrypus couriae*, male; b-*Neometrypus catiae*, male; c-*Tafalisca elongata*, male; d-*Truljalia hibinonis*, righ forewing. Scale: c – 1mm.

The stridulatory file (PCu vein with ventral stridulatory teeth) was present in the ancestral Oecanthidae. This condition was lost at least 11 times along the evolutionary history of this family in Euscyrtinae, *Thaumatogryllus variegatus* (Oecanthinae, Oecanthidi, Xabeini), Cearacesaini, Aphonomophini (Podoscirtinae, Hapithidi), Aphonoidini (Podoscirtinae, Podoscirtidi), the genus *Adenopterus* (Podoscirtinae, Podoscirtidi, Podoscirtini), Neometrypini (Tafaliscinae, Paroecanthidi), and three independent times within the genus *Tafalisca* (Tafaliscinae, Tafaliscidi) (Fig. 4).

Harp veins and mirror were also present in the ancestral FWs. The harp veins were lost eight times independently through time: in Euscyrtinae, *Thaumatogryllus variegatus* (Oecanthinae), Cearacesaini (91%), Aphonomorphini (Podoscirtinae) (82%), Aphonoidini (Podoscirtinae) (94%), *Pixipterus*, *Adenopterus* (Podoscirtinae) (90%), *Tafalisca*, and Neometrypini (Tafaliscinae) (96%). The loss of the mirror is congruent similar to the harp veins, except for *Matuanus aff. mirabilis* and *Archenopterus*, which also lost this structure (Fig. 5).

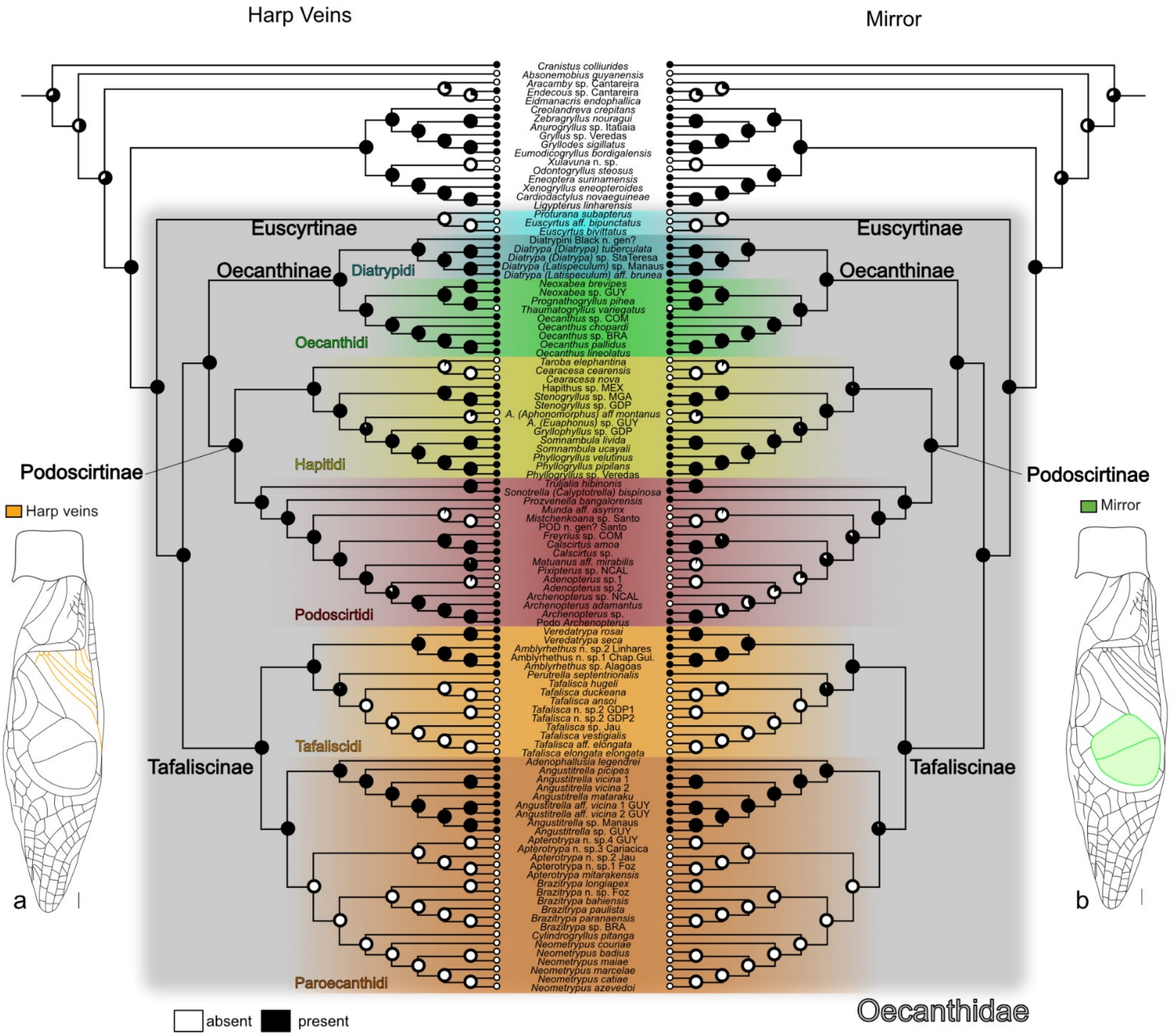


Figure 5. Ancestral state reconstruction of harp veins (left) and mirror (right) in Oecanthidae under maximum likelihood approach with equal rates (MK1). *Truljalia hibinonis*, right forewing: a- harp veins in yellow; b- mirror in green. Scale: 1mm.

Discussion

The monophyly of Oecanthidae is well supported within Grylloidea by molecular and morphological data (Campos *et al.*, submitted), and this family shows a remarkable morphological disparity, especially for FW development and properties, which may indicate a vast diversity of communication modalities. Thus, inner and outer auditory tympana are also variable, from absence to complete development, size, and shape.

Acoustic communication may have been the driving force behind the evolution of crickets (Otte, 1992; Desutter-Grandcolas, 1997a). The tegmino-tegminal stridulation in crickets, whose origin is independent of katydids (Tettigonioidea), has been present since its origin in the Lower Cretaceous (Nel, 2021). According to our results, all investigated characters responsible for sound production in Oecanthidae (forewings, stridulatory file, and resonators) are present in the ancestral of the clade (Figs. 3-5). It means that acoustic communication was already present since this lineage started to diversify around 130 million years ago (Lower Cretaceous) (Campos *et al.*, submitted). However, it was lost many times independently during the history of Oecanthidae, as shown by the loss of the stridulatory file and the reduction or loss of the FWs. According to our results, the lost structures (e.g. FWs or parts of SA) were never recovered again in the history of this clade.

The loss of sound production in Oecanthidae

The role of predation in the loss of acoustic communication has been widely hypothesized for crickets (Walker, 1964; Cade, 1975; Otte, 1990, 1992; Desutter-Grandcolas, 1998a, 2003; Desutter-Grandcolas *et al.*, 2017). This hypothesis associates the loss of acoustic communication with periods of intense predation throughout the evolutionary history of this group (Desutter-Grandcolas *et al.*, 2017). The fact that oecanthid crickets live in plants and consequently are more exposed to flying predators like bats, birds, and parasitoids reinforces the hypothesis of losing acoustic communication (losing FWs or the SA) can avoid acoustically oriented predators. The loss of the SA induced by parasitoids was already documented for a Hawaiian population of *Telleogryllus oceanicus* (Gryllidae) (Zuk *et al.*, 2006). Other adaptations related to acoustic communication that could help crickets avoid predators are changing the period/hour of the call, the duration of the calls, and emitting sound in higher/lower frequencies (Desutter-Grandcolas, 1998a, 1998b; Robillard *et al.*, 2013).

On the other hand, losing sound production gives space for developing another pre-existing communication, e.g., chemical and vibrational signaling. Pre-existent signaling could bypass the loss of acoustic communication, maintaining mating success in silent males (Bailey, 2003; Stritih-Peljhan and Virant-Doberlet, 2021). Once acoustic signaling was lost, our analysis shows that it was never recovered back inside the Oecanthidae clade (Figs 3-5). Our results also show that some oecanthid taxa, like Euscyrtinae and Neometrypini, have shown a high diversification despite the loss of acoustic communication, probably indicating that other replacing communication strategies have been developed.

Another hypothesis to explain the loss of acoustic communication is the association of some lineages of crickets with environments that are not favorable to that kind of communication (Song *et al.*, 2020). Since we know that forewings are responsible for producing crickets' songs, some reports of oecanthid crickets agree with this hypothesis. For example, species of *Riatina* (Podoscirtinae) and *Tafalisca* (Tafaliscinae) without SA (Campos *et al.*, submitted) were found inside wood galleries (Otte and Alexander, 1983; Campos *et al.*, 2020), an unfavorable habitat for acoustic signaling. Also, the Hawaiian endemic *Thaumatogryllus* is found in rock crevices (Otte, 1994), a habitat usually occupied by phalangopsid crickets, mainly species that do not present sound production, like *Eidmanacris* and *Socotracris*. At the opposite end, species of *Angustitrella* (Paroecanthini, Tafaliscinae), which have a fully developed SA and large tympana on the anterior face of the foretibia (Fig. 1F), are found in the Amazon canopies (LDC pers. obs.), a highly favorable habitat for the use of acoustic communication. Nevertheless, other taxa, that do not possess the necessary characteristics to produce loud airborne sounds, are frequently found in shorter trees, bushes, and grasses. This is the case for Aphonoidini (Podoscirtidi: Podoscirtinae), Aphonomorphini, Cearacesaini (Hapithidi: Podoscirtinae), Neometrypini (Paroecanthidi: Tafaliscinae), and Euscytinae. Species in lower habitats are more susceptible to acoustically-oriented predators than in high and complex canopies (Šipoš and Kindlmann, 2013). Unfortunately, habitat records for

Oecanthidae are far from being fully known. Because of this, it is not possible to test these hypotheses at this moment.

Our results show that several taxa in all Oecanthidae subfamilies have lost at least one important component responsible for sound production and/or propagation. These results suggest that many lineages of this family evolved independently for not emitting loud airborne sounds. The loss of acoustic communication has occurred in other families of crickets, like Odontogryllini (Gryllidae), Luzarinae (Phalangopsidae), *Eidmanacris* (Luzarinae, Gryllidae), and *Absonemobius* (Nemobiinae, Trigonidiidae) (e.g., Campos and De Mello, 2014; Campos *et al.*, 2017; Vicente *et al.*, 2017; Desutter-Grandcolas *et al.*, 2021).

Communication modalities in Oecanhidae

Even though they have lost acoustic communication, some oecanthid lineages as Aphonomorphini, Cearacesaini (Hapithidi: Podoscirtinae), some Podoscirtini (Podoscirtidi: Podoscirtinae), and some species of the genus *Tafalisca*, kept their tympana (Figs 3-5), probably to detect predators signals. An alternative hypothesis is that these crickets can produce another acoustic or vibratory signaling with their wings or body parts, and their tympana and vibrational receptors would be able to receive these signals. In forests, a place with intense bat predation, there are records of katydids using vibrational signals instead of acoustics (Gerhardt and Huber, 2002). A similar situation could happen in Oecanthidae, which has a similar general habit of tettigonids.

Crickets also developed other mechanisms to avoid predators. The use of high-frequency signals in Lebinthini (Eneopterinae: Gryllidae), for example, is used to confuse or mislead predators (Benavides-Lopez *et al.*, 2020). There are no records of high-frequency signals in Oecanthidae. Nevertheless, except for Oecanthinae (e.g., Walker, 1963; Bell, 1979, 1980; Sismondo, 1993; Collins *et al.*, 2019), bioacoustics is poorly documented in Oecanthidae. This is probably because of the difficulty of collecting these crickets in the vegetations (Campos and Desutter-Grandcolas, 2020). However, some clues indicate that oecanthid crickets also use other types of communication, favoring the loss of acoustic communication.

Vibrational communication is in the middle between chemical (close range) and acoustic signals (long-range) concerning distance propagation (Bell, 1980). This type of signal, more efficient and economical than airborne signals, is frequently reported in crickets and other orthopterans (e.g., Bell, 1980; Huber *et al.*, 1989; De Mello and dos Reis, 1994). Vibration is present in several cricket groups, suggesting that this communication modality could have appeared before acoustic communication (Stritih-Peljhan and Virant-Doberlet, 2021 and references therein).

Females of katydids are attracted to vibrational stimuli (Morris and Luca, 1998) as well as in Nemobiinae crickets (Richards, 1952). Crickets with fully developed SA like *Balamra gydia* (Trigonidiidae) communicate tapping the abdomen on vegetation (Huber *et al.*, 1989). The black-horned tree cricket *Oecanthus nigricornis* (Oecanthinae) also has a developed SA and uses vibrations on plants during courtship and post-mating behavior (Bell, 1980). Contrastly, crickets without sound-producing capacity also use vibrational signaling. The vibrational waves produced by the forewing stridulation can be helpful for mate location in dense vegetations (Gwynne, 2001). The acoustic communication was lost, but vibrational signals were kept. Besides having forewings only with longitudinal veins, some species of *Tafalisca*, like *T. elongata* or *T. vestigialis* kept the stridulatory file with ventral stridulatory teeth (Fig. 3). Some Aphonomorphini, like species of *Aphonomorphus*, have similar characteristics. These features suggest that using wings to produce vibrational signaling is possible for these crickets (Campos *et al.*, 2020). Moreover, a female of an undescribed species of *Tafalisca* was recorded drumming using the abdomen (Campos and Desutter-Grandcolas, 2020; Campos & Desutter-Grandcolas *in prep*.).

Oecanthidae signaling reception (acoustic or not)

In the proximal region of tibiae, subgenual organs are frequently mentioned as essential mechanoreceptors for vibrations in crickets (e.g., Huber *et al.*, 1989; Shaw, 1994; Gerhardt and Huber, 2002; Warren and Nowotny, 2021). These organs can receive both acoustic and vibrational signals (Shaw, 1994), and it is already demonstrated that they are intimately related to the hearing organs of crickets (when they are present) (Huber *et al.*, 1989). This fact could explain why some groups of Oecanthidae lost their tympana but still have sound-producing structures on their wings as Podoscirtidi (Podoscirtinae) and Tafaliscidi (Tafaliscinae). As mentioned before, some species of *Tafalisca* still have the stridulatory file, but almost all species lack the tympana. Interestingly, this genus has a notable character: a protuberance in the proximal region of the tibiae, a similar region of the subgenual organs (Campos *et al.*, 2020). The modified morphology of tibiae in *Tafalisca* suggests a hyper development of those mechanoreceptors, which could have an important role in their communication, probably receiving both acoustic and vibrational signals. Histological and behavioral analyses are necessary to test this hypothesis.

Ears originated multiple times in insects from different proprioceptors through their body (Fullard and Yack, 1993; Warren and Nowotny, 2021) and at least twice in orthopterans (Song *et al.*, 2020). The origin of tympana in Ensifera is posterior to sound-producing (Song *et al.*, 2020). That could indicate that the auditory system in crickets originated for intraspecific hearing and posteriorly co-opted for inter-specific sounds to avoid predators. In Oecanthidae, tibial tympana originated only once. Nevertheless, it was lost at least six times during the clade evolution.

Proprioceptors are distributed through the entire body of insects. In crickets, this is not different (Stritih-Peljhan and Virant-Doberlet, 2021). Even without tympana, it is already documented that crickets can receive airborne sounds and vibrations (Shaw, 1994). If crickets are losing the capacity to produce loud airborne sounds to avoid predators, they could also lose the tympana since other body receptors can play the same role. This situation could be energetically favorable for these crickets development.

The entire tribe Neometrypini (Paroecanthidi: Tafaliscinae) lost their tympana as well as the capacity to communicate acoustically. However, this lineage is more diverse compared to other Tafaliscinae (Campos and Desutter-Grandcolas, 2020; Campos and Souza-Dias, 2021; Cigliano *et al.*, 2022) and relatively abundant in field trips and collections (LDC pers. obs.). This tribe could be an example of a successful clade in the evolutionary history of Oecanthidae that greatly diversified after the loss of acoustic communication and hearing capacity with tibial tympana. Nevertheless, this group's behavior was never recorded, except for some brief notes about their mating behavior (Campos and Souza-Dias, 2021).

Resonators in oecanthid crickets

What about the forewing's resonators (harp and mirror)? Forewing's resonators are membranous regions of the anterior wings that amplify the vibrations generated by the rubbing between the teeth of the stridulatory file and the plectrum. Thus, improving the system of production and propagation of acoustic communication (Michelsen and Nocke, 1974). The presence of resonators contributes to the sound reaching long distances. The harp is the most effective, producing most of the sound followed by the mirror (Nocke, 1971; Bennet-Clark, 2003; Desutter-Grandcolas *et al.*, 2017). Harp veins and the mirror are generally present together in Oecanthidae (Fig. 5). Except for some Podoscirtini as the genus *Matuanus* and some species of *Riatina*, for example. The harp veins are present but mirror absent. The inverse does not occur.

Conclusion

This is the first evolutionary study of Oecanthidae in a phylogenetic frame. Despite the overall view of this family diversity, its actual diversity is much bigger than observed here, and some scenarios of its evolutionary history could change by adding new taxa to these analyses. However, we present here some important clues about the evolutionary history of these crickets and their probable history in acoustic communication. Oecanthidae is a diverse family concerning communication, acoustic or not. This lineage has been able to produce loud airborne sound since its diversity's origin ~130 Mya. However, it lost this ability as well as hearing several times independently through its evolutionary history and was never recovered. Besides the loss of sound-producing, oecanthid crickets have other types of communication (vibrational and chemical) that are considered as efficient as their acoustic communication. New records of the entire lineage of behavior and precise habitat details could be crucial information to understand the cause of losing acoustic communication as we know for crickets. The potential of Oecanthidae for studies about evolution is promising, and this is only the starting point to understand how communication impacts the diversity of this group.

References

Alexander, R.D. 1962. Evolutionary Change in Cricket Acoustical Communication. Evolution. 16, 443–467. doi:doi:10.2307/2406178

Bailey, W.J. 2003. Insects duets: underlying mechanisms and their evolution. Physiological Entomology. 28, 157–174.

Bell, P.D. 1980. Multimodal communication by the black-horned tree cricket, *Oecanthus nigricornis* (Walker) (Orthoptera Gryllidae). Canadian Journal of Zoology. 58, 1861–1868.

Bell, P.D. 1979. Rearing the black horned tree cricket, Oecanthus nigricornis (Orthoptera: Gryllidae). doi:10.4039/Ent112431-4

Benavides-Lopez, J.L., Ter Hofstede, H., Robillard, T. 2020. Novel system of communication in crickets originated at the same time as bat echolocation and includes male-male multimodal communication. The Science of Nature. 107, 9. doi:10.1007/s00114-020-1666-1

Bennet-Clark, H.C. 2003. Wing resonances in the Australian field cricket *Teleogryllus oceanicus*. Journal of Experimental Biology. 206, 1479–1496. doi:10/dbv9xh

Béthoux, O. 2012. Grylloptera – a unique origin of the stridulatory file in katydids, crickets, and their kin (Archaeorthoptera). Arthropod Systematics and Phylogeny. 70, 43–68.

Cade, W. 1975. Acoustically Orienting Parasitoids: Fly Phonotaxis to Cricket Song. Science. 190, 1312–1313. doi:10.1126/science.190.4221.1312

Cade, W.H., Rice, R. 1980. Field Crickets (Orthoptera:Gryllidae) as a Prey of the Toad *Bufo marinus*. The Canadian Entomologist. 112, 335–336. doi:10.4039/Ent112335-3

Campos, L.D. de, Desutter-Grandcolas, L. 2020. The Paroecanthini crickets (Orthoptera: Grylloidea: Gryllidae: Oecanthinae) from French Guiana. Zoosystema. 42, 355–398. doi:10.5252/zoosystema2020v42a20

Campos, L.D. de, Souza-Dias, P.G.B. de, Desutter-Grandcolas, L., Nihei, S.S. 2021. Colonization of different biomes drove the diversification of the Neotropical Eidmanacris crickets (Insecta: Orthoptera: Grylloidea: Phalangopsidae). PLOS ONE. 16, e0245325. doi:10.1371/journal.pone.0245325

Campos, L.D. de, Souza-Dias, P.G.B. 2021. Hidden in the bushes: uncovering the diversity of the genus *Neometrypus* Desutter, 1988 n. status (Orthoptera: Gryllidae: Paroecanthini: Tafaliscina) in Neotropical forests. Zootaxa. 5060, 451–488. doi:10.11646/zootaxa.5060.4.1

Campos, L.D. de, Souza-Dias, P.G.B., Nihei, S.S. 2020. New Brazilian Tafaliscina increase the diversity of this Neotropical cricket clade (Orthoptera: Grylloidea: Gryllidae: Oecanthinae: Paroecanthini). Zoosystema. 42, 331–353. doi:10.5252/zoosystema2020v42a19

Campos, L.D. de, Souza-Dias, P.G.B., Nihei, S.S. 2017. Taxonomic review of *Eidmanacris* Chopard, 1956 (Orthoptera: Grylloidea: Phalangopsidae). Zootaxa. 4321, 1–93. doi:10.11646/zootaxa.4321.1.1

Campos, L.D., De Mello, F.A.G. 2014. Taxonomic studies on the Neotropical Landrevinae with description of new taxa (Orthoptera, Grylloidea, Gryllidae). Zootaxa. 3852, 151–178. doi:10.11646/zootaxa.3852.2.1

Campos, L.D. de, Souza-Dias, P.G.B. de, Audino, J.A, Desutter-Grandcolas, L., Nihei, S.S. The Fifth Family of the True Crickets (Ensifera, Grylloidea), Oecanthidae n. status: phylogenetic relationships and divergence times. Submitted.

Cigliano, M.M., Braun, H., Eades, D.C., Otte, D. 2022. Orthoptera Species File. Version 5.0/5.0 [WWW document] [WWW Document]. URL http://orthoptera.speciesfile.org (accessed 1.7.22).

Collins, N., González, I.M.C., Govaerts, B.V.A. 2019. Oecanthus mhatreae sp. nov. (Gryllidae: Oecanthinae): A new species of tree cricket from Mexico, with an irregular song pattern and unique chirp-like trill configuration. Journal of Orthoptera Research. 28, 137–143. doi:10.3897/jor.28.33781

De Mello, F.D.A.G., dos Reis, J.C. 1994. Substrate drumming and wing stridulation performed during coutship by a new Brazilian cricket (Orthoptera: Grylloidea: Phalangopsidae). Journal of Orthoptera Research. 2, 21–24.

Desutter, L. 1987. Structure et évolution du complexe phallique des Gryllidea (Orthoptères) et classification des genres Néotropicaux de Grylloidea. Primière Partie. Annales de La Société Entomologique de France. 23, 213–239.

Desutter-Grandcolas, L. 2003. Phylogeny and the evolution of acoustic communication in extant Ensifera (Insecta, Orthoptera). Zoologica Scripta. 32, 525–561. doi:10.1046/j.1463-6409.2003.00142.x

Desutter-Grandcolas, L. 1998a. Broad-frequency modulation in cricket (Orthoptera, Grylloidea) calling songs: two convergent cases and a funtional hypotesis. Canadian Journal of Zoology. 76, 2148–2163.

Desutter-Grandcolas, L. 1998b. Pulse duration and effectiveness of acoustic communication in crickets (Orthoptera: Grylloidea): The case of *Paragryllodes campanella* , sp. n. (Phalangopsidae). Annales de la Societé entomologique de France. 34, 407–418.

Desutter-Grandcolas, L. 1997a. Acoustic communication in crickets (Orthoptera: Grylloidea): A model of Regressive Evolution revisited using phylogeny. Memoires du Museum National d'Histoire Naturelle. 173, 183–202.

Desutter-Grandcolas, L. 1997b. A phylogenetic analysis of the evolution of the stridulatory apparatus in true crickets (Orthoptera, Grylloidea). Cladistics. 13, 101–108.

Desutter-Grandcolas, L., Hugel, S., Nel, A., Warren, B.H., Souza-Dias, P., Chintauan-Marquier, I.C. 2021. Updated diagnoses for the cricket family Trigonidiidae (Insecta: Orthoptera: Grylloidea) and its subfamilies (Trigonidiinae, Nemobiinae), with a review of the fossil record. Zoologischer Anzeiger. doi:10/gk8fnb

Desutter-Grandcolas, L., Jacquelin, L., Hugel, S., Boistel, R., Garrouste, R., Henrotay, M., Warren, B.H., Chintauan-Marquier, I.C., Nel, P., Grandcolas, P., Nel, A. 2017. 3-D imaging reveals four extraordinary cases of convergent evolution of acoustic communication in crickets and allies (Insecta). Scientific Reports. 7, 1–8. doi:10.1038/s41598-017-06840-6

Desutter-Grandcolas, L., Robillard, T. 2004. Acoustic evolution in crickets: Need for phylogenetic study and a reappraisal of signal effectiveness. Anais da Academia Brasileira de Ciencias. 76, 301–315. doi:10.1590/S0001-37652004000200019

Dong, J., Kergoat, G.J., Vicente, N., Rahmadi, C., Xu, S., Robillard, T. 2018. Biogeographic patterns and diversification dynamics of the genus Cardiodactylus Saussure (Orthoptera, Grylloidea, Eneopterinae) in Southeast Asia. Molecular Phylogenetics and Evolution. 129, 1–14. doi:10.1016/j.ympev.2018.06.001

Elliott, C.J.H., Koch, U.T. 1985. The clockwork cricket. Naturwissenschaften. 72, 150–153. doi:10.1007/BF00490404

Elliott, C.J.H., Koch, U.T. 1983. Sensory feedback stabilizing reliable stridulation in the field cricket Glyllus campestris L.. Animal Behaviour. 31, 887–901. doi:10.1016/S0003-3472(83)80244-9

Fullard, J.H., Yack, J.E. 1993. The evolutionary biology of insect hearing. Trends in Ecology & Evolution. 8, 248–252. doi:10.1016/0169-5347(93)90200-9

Gerhardt, H.C., Huber, F. 2002. Acoustic communication in insects and anurans: common problems and diverse solutions. University of Chicago Press.

Gorochov, A.V. 2017. Taxonomy of Podoscirtinae (Orthoptera: Gryllidae). Part 11: the tribe Hapithini and other American taxa. Zoosystematica Rossica. 26, 11–106.

Gwynne, D.T. 2001. Katydids and bush-crickets: reproductive behavior and evolution of the Tettigoniidae. Cornell University Press.

Gwynne, D.T. 1995. Phylogeny of the Ensifera (Orthoptera): A Hypothesis Supporting Multiple Origins of Acoustical Signalling, Complex Spermatophores and Maternal Care in Crickets, Katydids, and Weta. Journal of Orthoptera Research. 4, 203–218. doi:10.2307/3503478

Huber, F., Moore, T.E., Loher, W. 1989. Cricket Behavior and Neurobiology.

Jost, M.C., Shaw, K.L. 2006. Phylogeny of Ensifera (Hexapoda: Orthoptera) using three ribosomal loci, with implications for the evolution of acoustic communication. Molecular Phylogenetics and Evolution. 38, 510–530. doi:10.1016/j.ympev.2005.10.004

Koch, U.T., Elliott, C.J.H., Schäffner, K.-H., Kleindienst, H.-U. 1988. The mechanics of stridulation of the cricket *Gryllus campestris*. Journal of Comparative Physiology A. 162, 213–223. doi:10.1007/BF00606086

Maddison, W.P., Maddison, D.R. 2021. Mesquite: a modular system for evolutionary analysis.

Michelsen, A., Nocke, H. 1974. Biophysical Aspects of Sound Communication in Insects, in: Treherne, J.E., Berridge, M.J., Wigglesworth, V.B. (Eds.), Advances in Insect Physiology. Academic Press, pp. 247–296. doi:10.1016/S0065-2806(08)60131-9

Montealegre-Z, F., Windmill, J.F.C., Morris, G.K., Robert, D. 2009. Mechanical phase shifters for coherent acoustic radiation in the stridulating wings of crickets: the plectrum mechanism.. The Journal of experimental biology. 212, 257–269. doi:10.1242/jeb.022731

Morris, G., Luca, P. de. 1998. Courtship Communication in Meadow Katydids: Female Preference for Large Male Vibrations. Behaviour. 135, 777–794. doi:https://doi.org/10.1163/156853998792640422

Nel, A. 2021. Impact of the choices of calibration points for molecular dating: a case study of Ensifera. Palaeoentomology. 4. doi:10.11646/palaeoentomology.4.3.9

Nocke, H. 1971. Biophysik der Schallerzeugung durch die Vorderflügel der Grillen. Zeitschrift für vergleichende Physiologie. 74, 272–314.

Otte, D. 1994. The crickets of Hawaii: origin, systematics, and evolution. The Orthopterists' Society, Philadelphia.

Otte, D. 1992. Evolution of Cricket Songs. Journal of Orthoptera Research. 25–49. doi:10.2307/3503559

Otte, D. 1990. The relation between hearing and flying in crickets.. Entomological News. 101, 29–34.

Otte, D., Alexander, R.D. 1983. The Australian crickets (Orthoptera: Gryllidae).. The Australian crickets (Orthoptera: Gryllidae).

Otte, D., Pérez-Gelabert, D.E. 2009. Caribbean crickets. Orthopterists' Society.

Pagel, M. 1998. Inferring evolutionary processes from phylogenies 26, 331–348.

Ragge, D.R. 1955. The wing-venation of the Orthoptera Saltatoria, with notes on Dictyopteran wing-venation. British Museum (Natural History), London.

Richards, T. 1952. *Nemobius sylvestris* in SE Devon. Entomologist. 85, 83–87.

Robillard, T., Desutter-grandcolas, L. 2011. Evolution of calling songs as multicomponent signals in crickets (Orthoptera : Grylloidea : Eneopterinae) 50, 627–672. doi:10.1163/000579511X572044

Robillard, T., Desutter-Grandcolas, L. 2004. Phylogeny and the modalities of acoustic diversification in extant Eneopterinae (Insecta, Orthoptera, Grylloidea, Eneopteridae). Cladistics. 20, 271–293. doi:10.1111/j.1096-0031.2004.00025.x

Robillard, T., Montealegre-Z, F., Desutter-Grandcolas, L., Grandcolas, P., Robert, D. 2013. Mechanisms of high-frequency song generation in brachypterous crickets and the role of ghost frequencies. Journal of Experimental Biology. 216, 2001–2011. doi:10.1242/jeb.083964

Römer, H., Butlin, R.K., Guilford, T., Krebs, J.R. 1993. Environmental and biological constraints for the evolution of long-range signalling and hearing in acoustic insects. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. 340, 179–185. doi:10.1098/rstb.1993.0056

Schneider, W.T., Rutz, C., Hedwig, B., Bailey, N.W. 2018. Vestigial singing behaviour persists after the evolutionary loss of song in crickets. Biology Letters. 14, 20170654. doi:10/ckk7

Schubnel, T., Desutter-Grandcolas, L., Legendre, F., Prokop, J., Mazurier, A., Garrouste, R., Grandcolas, P., Nel, A. 2019. To be or not to be: postcubital vein in insects revealed by microtomography. Systematic Entomology. 1–10. doi:10.1111/syen.12399

Shaw, S.R. 1994. Detection of airborne sound by a cockroach "vibration detector": a possible missing link in insect auditory evolution. Journal of Experimental Biology. 193, 13–47. doi:10.1242/jeb.193.1.13

Šipoš, J., Kindlmann, P. 2013. Effect of the canopy complexity of trees on the rate of predation of insects. Journal of Applied Entomology. 137, 445–451. doi:10/f4zwwp

Sismondo, E. 1993. Ultrasubharmonic resonance and nonlinear dynamics in the song of *Oecanthus nigricornis* F. Walker (Orthoptera : Gryllidae). International Journal of Insect Morphology and Embryology. 22, 217–231. doi:10.1016/0020-7322(93)90011-O

Song, H., Béthoux, O., Shin, S., Donath, A., Letsch, H., Liu, S., McKenna, D.D., Meng, G., Misof, B., Podsiadlowski, L., Zhou, X., Wipfler, B., Simon, S. 2020. Phylogenomic analysis sheds light on the evolutionary pathways towards acoustic communication in Orthoptera. Nature Communications. 2020, 4939. doi:10.1038/s41467-020-18739-4

Stritih-Peljhan, N., Virant-Doberlet, M. 2021. Vibrational signalling, an underappreciated mode in cricket communication. The Science of Nature. 108, 41. doi:10/gmq6gz

Tan, M.K., Malem, J., Legendre, F., Dong, J., Baroga-Barbecho, J.B., Yap, S.A., Wahab, R. bin H.A., Japir, R., Chung, A.Y.C., Robillard, T. 2021. Phylogeny, systematics and evolution of calling songs of the Lebinthini crickets (Orthoptera, Grylloidea, Eneopterinae), with description of two new genera. Systematic Entomology. 46, 1060–1087. doi:10/gmsd9r

Vicente, N., Kergoat, G.J., Dong, J., Yotoko, K., Legendre, F., Nattier, R., Robillard, T. 2017. In and out of the Neotropics: historical biogeography of Eneopterinae crickets. Journal of Biogeography. 44, 2199–2210. doi:10.1111/jbi.13026

Walker, T.J. 1964. Experimental Demonstration of a Cat Locating Orthopteran Prey by the Prey's Calling Song. The Florida Entomologist. 47, 163–165. doi:10.2307/3493290

Walker, T.J. 1963. The Taxonomy and Calling Songs of United States Tree Crickets (Orthoptera: Gryllidae: Oecanthinae). II. The nigricornis Group of the Genus Oecanthus1. Annals of the Entomological Society of America. 56, 772–789. doi:10.1093/aesa/56.6.772

Warren, B., Nowotny, M. 2021. Bridging the Gap Between Mammal and Insect Ears – A Comparative and Evolutionary View of Sound-Reception. Frontiers in Ecology and Evolution. 0. doi:10/gmfbsq

Yack, J.E., Raven, B.H., Leveillee, M.B., Naranjo, M. 2020. What Does an Insect Hear? Reassessing the Role of Hearing in Predator Avoidance with Insights from Vertebrate Prey. Integrative and Comparative Biology. 60, 1036–1057. doi:10.1093/icb/icaa097

Zuk, M., Rotenberry, J.T., Tinghitella, R.M. 2006. Silent night : adaptive disappearance of a sexual signal in a parasitized population of field crickets 2, 521–524. doi:10.1098/rsbl.2006.0539

Supporting information

Table S1. Ancestral state reconstruction characters. Inner tympanum: 0-absent, 1-present; outer tympanum: 0-absent, 1-present; forewings: 0-absent, 1-brachypterous, 2-developed; stridulatory file: 0-absent, 1-present; harp veins: 0-absent, 1- present; mirror: 0-absent, 1-present.

Taxon	Inner tympanum	Outer tympanum	Forewings development	Stridulatory file	Harp veins	Mirror
A. (Aphonomorphus) aff. montanus	1	0	2	0	0	0
A. (Euaphonus) sp.	1	0	2	0	0	0
Absonemobius guyanensis	0	0	0	0	0	0
Adenophallusia legendrei	1	0	2	1	1	1
Adenopterus sp.1	1	1	2	0	0	0
Adenopterus sp.2	1	1	2	0	0	0
Amblyrehthus n.sp.2 Linhares	1	1	2	1	1	1
Amblyrehthus sp. Alagoas	1	1	2	1	1	1
Amblyrhethus n.sp.1 Chap	1	1	2	1	1	1
*Angistitrella vicina*1	1	1	2	1	1	1
*Angistitrella vicina*2	1	1	2	1	1	1
*Angustitrella aff. vicina*1	1	1	2	1	1	1
Angustitrella mataraku	1	1	2	1	1	1
Angustitrella picipes	1	1	2	1	1	1
Angustitrella sp. GUY	1	1	2	1	1	1
Angustitrella sp. GUY2	1	1	2	1	1	1
Angustitrella sp. Manaus	1	1	2	1	1	1
Anurogryllus sp. Itatiaia	1	1	2	1	1	1
Apterotrypa mitarakensis	0	0	0	0	0	0
Apterotrypa n.sp.1 Foz	0	0	0	0	0	0
Apterotrypa n.sp.2 Jau	0	0	0	0	0	0
Apterotrypa n.sp.3 Cariacica	0	0	0	0	0	0
Apterotrypa n.sp.4 GUY	0	0	0	0	0	0
Aracamby sp.	0	0	1	1	0	0
Archenopterus sp.	1	1	2	1	1	1
Archenopterus sp. NCAL	1	1	2	1	1	1
Archepterus adamantus	1	1	2	1	1	0
Brazitrypa bahiensis	0	0	2	0	0	0
Brazitrypa longiapex	0	0	2	0	0	0
Brazitrypa nsp Foz	0	0	2	0	0	0
Brazitrypa paranaensis	0	0	2	0	0	0
Brazitrypa paulista	0	0	2	0	0	0
Brazitrypa sp. BRA	0	0	2	0	0	0
Calscirtus amoa	1	1	2	1	1	1
Calscirtus sp.	1	1	2	1	1	1
Cardiodactylus novaeguineae	1	1	2	1	1	1
Cearacesa cearensis	1	0	2	0	0	0
Cearacesa nova	1	0	2	0	0	0
Cranistus colliurides	1	1	2	1	1	1
Creolandreva crepitans	1	1	2	1	1	1
Cylindrogryllus pitanga	0	0	1	0	0	0
D. (Latispeculum) aff. brunnea	1	1	2	1	1	1

Table S1. Ancestral state reconstruction characters. Inner tympanum: 0-absent, 1-present; outer tympanum: 0-absent, 1-present; forewings: 0-absent, 1-brachypterous, 2-developed; stridulatory file: 0-absent, 1-present; harp veins: 0-absent, 1- present; mirror: 0-absent, 1-present. Continued.

Taxon	**Inner tympanum**	**Outer tympanum**	**Forewings development**	**Stridulatory file**	**Harp veins**	**Mirror**
D. (Latispeculum) sp. Manaus	1	1	2	1	1	1
D.(Diatrypa) sp. StaTeresa	1	1	2	1	1	1
D.(Diatrypa) tuberculata	1	1	2	1	1	1
Diatrypini black n.gen.	1	1	1	1	1	1
Eidmanacris endophallica	0	0	1	0	0	0
Endecous sp.	1	0	2	1	1	1
Eneoptera surinamensis	1	1	2	1	1	1
Eumodicogryllus bordigalensis	0	1	2	1	1	1
Euscyrtus aff. bipunctatus	0	0	1	0	0	0
Euscyrtus bivittatus	1	1	1	0	0	0
Freyrius sp.	1	1	2	1	1	1
Gryllodes sigillatus	0	1	2	1	1	1
Gryllophyllus sp.	0	1	2	1	1	1
Gryllus sp. Veredas	1	1	2	1	1	1
Hapithus sp.	1	0	2	1	1	1
Ligypterus linharensis	1	1	2	1	1	1
Matuanus aff. mirabilis	1	1	2	1	1	0
Mistchenkoana sp.	1	0	2	0	0	0
Munda aff. asyrinx	1	1	2	0	0	0
Neometrypus badius	0	0	1	0	0	0
Neometrpus couriae	0	0	0	0	0	0
Neometrypus catiae	0	0	1	0	0	0
Neometrypus marcelae	0	0	1	0	0	0
Neometrypus *azevedoi*	0	0	1	0	0	0
Neometrypus maiae	0	0	1	0	0	0
Neoxabea brevipes	1	1	2	1	1	1
Neoxabea sp. GUY	1	1	2	1	1	1
Odontogryllus setosus	0	0	1	0	0	0
Oecanthus chopardi	1	1	2	1	1	1
Oecanthus lineolatus	1	1	2	1	1	1
Oecanthus pallidus	1	1	2	1	1	1
Oecanthus sp. BRA	1	1	2	1	1	1
Oecanthus sp. COM	1	1	2	1	1	1
Perutrella septentrionalis	1	1	2	1	1	1
Phyllogryllus pipilans	1	1	2	1	1	1
Phyllogryllus sp. Veredas	1	1	2	1	1	1
Phyllogryllus velutinus	1	1	2	1	1	1
Pixipterus sp. NCAL	0	0	2	0	0	0
POD n.gen. Santo	1	0	2	0	0	0
Podo *Archenopterus*	1	1	2	1	1	1
Prognathogryllus pihea	1	1	2	1	1	1
Proturana subapterus	0	0	1	0	0	0

Conclusões Gerais

Datada do Cretáceo Inferior (~130 Milhões de anos atrás), Oecanthidae n. status é estabelecida como a quinta família monofilética de Grylloidea, baseado em dados moleculares e morfológicos. Essa linhagem, com distribuição mundial, é dividida em quatro subfamílias: Euscyrtinae, Oecanthinae n. def., Tafaliscinae n. def. n. status e Podoscirtinae n. def. Esse primeiro e importante passo para futuros estudos evolutivos de Oecanthidae n. status, é realizado através de filogenias bem suportadas e calibradas, as quais são utilizadas para revisar e estabilizar a classificação desse grupo tão diverso. Esse é o primeiro estudo evolutivo de Oecanthidae n. status em um contexto filogenético. Oecanthidae é uma família diversa no que se diz respeito à comunicação, acústica ou não. Essa linhagem tem sido capaz de produzir sinais acústicos desde sua origem a 130 milhões de anos atrás. No entanto, a perda dessa habilidade, assim como a capacidade de ouvir através de membranas timpânicas, aconteceu diversas vezes ao longo de sua história evolutiva. Novos dados de comportamento e observações precisas dos habitats desse clado são informações cruciais para entender a causa da perda da comunicação acústica nesses grilos.

O potencial de Oecanthidae n. status para estudos evolutivos mostra-se bastante promissor. Esse é apenas o ponto de partida para entender como a comunicação impactou e impacta esse diverso grupo de grilos arborícolas. Além disso, esse clado e suas linhagens internas são possíveis grupos modelo para diversas áreas da Biologia como: biogeografia, bioacústica, comportamento e ecologia. Tudo isso, graças a sua grande diversidade de formas e tamanhos, distribuição mundial com diversificações regionais, e um possível repertório de comunicação, acústico ou não, que se mantém ainda pouco explorado atualmente.