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**LEVANTAMENTO DA AVIFAUNA EM UMA UNIDADE DE PROTEÇÃO INTEGRAL NA
ZONA LIMÍTROFE À MARGEM DO RIO IGUAÇU**

LARANJEIRAS DO SUL, 2023

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Trabalho apresentado ao curso de Licenciatura em Ciências
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Trabalho de Conclusão de Curso II
Orientador: Alexandre Monkolski

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Trabalho de conclusão de curso de graduação apresentado como requisito para a obtenção do grau de Licenciado(a) em Ciências Biológicas da Universidade Federal da Fronteira Sul - *Campus* Laranjeiras do Sul.

Orientador: Alexandre Monkolski

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"Não são as espécies mais fortes que sobrevivem nem as mais inteligentes, e sim as mais suscetíveis a mudanças."

Charles Darwin

Este trabalho segue as normas da revista

ZOOLOGIA CURITIBA

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Levantamento da avifauna em uma Unidade de Proteção Integral na zona limítrofe à margem do Rio Iguaçu

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Resumo: Ecossistemas de Mata Atlântica abrigam uma elevada densidade e diversidade de aves. No Paraná, dados referentes à composição, adaptação e comportamento da avifauna em matas com diferentes condições de equilíbrio ainda são obscuros. A pesquisa objetivou investigar a estrutura da avifauna em diferentes locais de uma unidade de proteção integral e inferir possíveis interações ecológicas que determinam a variação faunística. O estudo foi conduzido na Estação Ecológica Municipal Paulo Pinto de Oliveira, às margens do Rio Iguaçu, durante 6 meses, foram estabelecidas 10 estações de amostragem com 5 transectos de busca ativa, efetuando observações, registros sonoros e fotográficos. Um total de 116 espécies foram registradas, distribuídas em 43 famílias, representando aproximadamente 15% da avifauna do estado. Os dados integrados de abundância, diversidade e guilda trófica permitiram observar que as aves se distribuem de acordo com as características fitofisionômicas dos locais amostrados, desenvolvendo diferentes estratégias de sobrevivência. Os dados de abundância submetidos ao escalonamento multidimensional não métrico (nMDS) evidenciaram que as estações de amostragem com similaridade de fauna possuem a paisagem composta pelas semelhantes tipologias vegetais. Foi observado no local uma grande diversidade de aves que atuam no equilíbrio da biota dispersando sementes, otimizando a polinização e estabilizando a cadeia trófica, desenvolvendo relações de exploração de recursos alimentares e procura de abrigos que influenciam na sua distribuição. O levantamento das espécies e suas relações ecológicas podem colaborar para o desenvolvimento de estratégias de conservação da unidade.

Palavras-chave: aves, fragmentos florestais, biodiversidade, guildas tróficas, ecótono, mata atlântica, amostragem por pontos.

Abstract: Atlantic Forest ecosystems harbor a high density and diversity of birds. In Paraná, data referring to the composition, adaptation and behavior of the avifauna in forests with different equilibrium conditions are still unclear. The research aimed to investigate the structure of the avifauna in different places of an integral protection unit and to infer possible ecological interactions that determine the faunistic variation. The study was conducted at the Paulo Pinto de Oliveira Municipal Ecological Station, on the banks of the Iguaçu River, for 6 months, 10 sampling stations were established with 5 active search transects, making observations, sound and photographic records. A total of 116 species were recorded, distributed in 43 families, representing approximately 15% of the state's avifauna. The integrated data of abundance, diversity and trophic guild allowed observing that the birds are distributed according to the phytophysionomic characteristics of the sampled places, developing different survival strategies. The abundance data submitted to non-metric multidimensional scaling (nMDS) showed that the sampling stations with fauna similarity have the landscape composed by similar vegetal typologies. A great diversity of birds was observed at the site that act in the balance of the biota by dispersing seeds, optimizing pollination and stabilizing the trophic chain, developing relationships to explore food resources and search for shelters that influence their distribution. The survey of species and their ecological relationships can contribute to the development of conservation strategies for the unit.

Keywords: birds, forest fragments, biodiversity, trophic guilds, ecotone, atlantic forest, point sampling.

INTRODUÇÃO

Um terço das espécies de aves existentes no planeta são encontradas na América do Sul. O Brasil apresenta a maior diversidade biológica do mundo, com ocorrência de 1.971 espécies de aves residentes e migratórias, correspondendo a mais da metade dos registros para a América do Sul. Destas, 1.742 são residentes ou migram para se reproduzir e construir ninhos (293 sendo endêmicos do Brasil), 126 espécies aparecem de forma recorrente fazendo visitas sazonais não tendo relação com a reprodução, e 103 são de ocorrência eventual ou acidental, consideradas vagantes (Pacheco et al. 2021).

A abundância de espécies de aves nativas diagnostica a integridade biótica num ecossistema, permitindo estabelecer delimitações de áreas mais ou menos preservadas. As aves ocupam diversos nichos ecológicos e estão presentes em todos os biomas, sendo consideradas boas indicadoras da diversidade de ecossistemas. Quando as espécies exóticas se sobressaem às espécies nativas, obtém-se indicativos de eventos de alteração ambiental que podem ser investigadas ao longo de uma escala espacial e temporal. O levantamento de aves é um método compatível e eficiente para demonstrar os impactos antrópicos da alteração estrutural do ambiente, estabelecendo bases para protocolos de manejo do ecossistema, em detrimento da vulnerabilidade (Vielliard 2010).

As peculiaridades comportamentais das aves em relação a exploração de recursos no ambiente aquático e terrestre, as colocam numa posição de status para radiografar processos ecológicos. Distintas estratégias ecológicas em relação aos recursos determinam a ocorrência de espécies comuns generalistas e espécies raras com hábitos específicos. Nas áreas de proteção e conservação ambiental, a identificação dessas diferentes populações fornece subsídios para manejo do ecossistema, a fim de otimizar condições para sobrevivência das populações de aves silvestres (Baesse 2015).

A Mata Atlântica possui elevada biodiversidade de espécies, além de uma alta taxa de endemismo com espécies incluídas na listagem do IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) e da IUCN (União Internacional para a Conservação da Natureza). Deste modo, a conservação desse bioma é fundamental para a conservação das aves, pois a perda de ambientes naturais de Mata Atlântica reflete diretamente sobre a avifauna (Cordeiro 2003). A fragmentação nesses biomas é um processo marcante de transformação da cobertura vegetal, fortemente influenciada por ações antrópicas, como as monoculturas em substituição a ecossistemas naturais com vegetação nativa, reduzindo a diversidade da avifauna.

A Estação Ecológica Municipal Paulo Pinto de Oliveira (EEMPPPO) ainda conserva características originais da vegetação semidecidual estacional. O fato da recente fundação da área como unidade de proteção integral e a escassez de dados regionais concretos a respeito da fauna em geral, torna esse ambiente um elemento chave para ampliação de conhecimento de taxocenose. Assim a proposta do presente trabalho tem como foco o levantamento da avifauna em diferentes ambientes em uma unidade de proteção integral sob influência de uma área limítrofe ao lago artificial de uma Usina Hidrelétrica.

MATERIAIS E MÉTODOS

O estudo foi conduzido na Estação Ecológica Municipal Paulo Pinto de Oliveira (25° 34' 13.64" S 52° 17' 43.99" O), entre o período de março a maio de 2022. A unidade está localizada no município de Porto Barreiro (figura 1), situado na região centro-sul do estado do Paraná, a uma altitude de 770 metros. O clima da região é classificado como Cfb, com pluviosidade variando de 1100 a 2000 mm, temperatura média de 20°C e umidade relativa do ar de 70 a 80%. A área encontra-se dentro do bioma Mata Atlântica, no ecótono entre as formações vegetais Floresta Ombrófila Mista (0.72 ha) e Floresta Estacional Semidecidual (452.58 ha), totalizando 453,3 ha.

Fundada no ano de 2018, a EEMPPPO está localizada próxima a Comunidade Porto Pinheiro e Santíssima Trindade, às margens do Rio Iguazu, numa região de alagado da represa Salto Santiago. É enquadrada como uma Unidade de Conservação (UC) de proteção integral, sendo uma área de grande importância para a preservação dos ecossistemas naturais, configurando um refúgio para subsistência e reprodução de diversas espécies silvestres. A estação ecológica tem como objetivos incentivar estudos faunísticos e pesquisas científicas e desenvolver trabalhos de Educação Ambiental, sendo a sua visitação controlada.



Figura 1. Vista aérea da Estação Ecológica Municipal Paulo Pinto de Oliveira em Porto Barreiro (PR). Pontos indicam as estações de amostragem dentro da zona limítrofe com o lago da Usina Hidrelétrica de Salto Santiago. Fonte: Adaptado de Map data 2023 (C) Google e Wikimedia Open Street Map (2023)

Para otimizar o trabalho de levantamento faunístico foram determinadas áreas com configurações fitofisionômicas específicas para compor as estações de amostragem. Foram definidas áreas com as seguintes composições: F1 - Mata ciliar secundária (vegetação esparsa) circundada por áreas abertas (campo) com presença de pequenas propriedades rurais no seu entorno; F2 - Mata ciliar secundária (com vegetação fechada); F3 - Floresta secundária em estado de regeneração (onde se percebe ainda a presença de espécies vegetais exóticas); F4 - Ambiente composto por vegetação esparsa, áreas úmidas e capoeiras de vegetação nativa; F5 - Floresta clímax ou mata virgem com predomínio de espécies de grande porte, médio e pequeno porte, que representam o mais próximo da flora original típica de Mata Atlântica.

A metodologia utilizada para o levantamento das aves foi por meio de pontos fixos, em toda a borda da EEMPPO margeada pelo lago da Usina Hidrelétrica de Salto Santiago, com repetições das unidades amostrais. A área de borda foi dividida em dez estações para observação, afastadas aproximadamente 1000 m, com cinco pontos pseudoréplicas (transectos) distanciados em 100 m um do outro. As observações foram efetuadas semanalmente no período da manhã das 6h às 11h, respeitando o fotoperíodo. Nas estações de amostragem foram estabelecidos pontos de observação e escuta ao longo dos transectos. O tempo de amostragem total foi de 5 horas, considerando 40 min de esforço amostral por transecto e 10 min de deslocamento entre as estações amostrais (metodologia adaptada de Anjos 2010).

As aves foram observadas e localizadas nos estratos vegetais com o auxílio de binóculos Celestron (10x42), e os registros fotográficos efetuados com câmera fotográfica Canon EOS-Rebel SL3. O aparelho celular Apple iPhone 13, também foi usado para registro complementar de imagens, vídeos e sons das aves. Os registros obtidos em “in situ” foram transcritos num diário de campo (anotações - caderno).

A identificação de espécies teve como base referencial bibliográfico especializado nas obras de Ridgely et al. (2015), Sick Helmut (1997), site de identificação WikiAves e base de dados do Merlin Bird para auxílio na identificação dos áudios. Os registros visuais e sonoros das Aves foram agrupados para organização sistemática em planilha do EXCEL levando em consideração aspectos qualitativos (riqueza de espécies) e quantitativos (número de indivíduos observados/contatos).

Os dados de registros de espécies foram submetidos aos cálculos de índice de diversidade de Shannon-Winner, dominância de Simpson e equitabilidade de Pielou para obter um panorama de diferenças de espécies para as estações de amostragem. As diferenças entre os valores de diversidade foram estabelecidas com o uso do teste de Hutcheson.

A frequência de ocorrência (FO) foi calculada de acordo com Aleixo e Vielliard 1995, com objetivo de avaliar a regularidade com que uma espécie é encontrada em uma determinada área. O índice pontual de abundância (IPA) (Bibby et al. 2000), foi calculado para cada área amostrada com o intuito de se comparar a abundância das espécies de aves em cada área. Os dados de frequência de ocorrência foram distribuídos em classes ou categorias de ocupação de habitat sendo classificados em: a) residentes – $FO \geq 60\%$; b) prováveis residentes – $60\% > FO > 15\%$ e; c) ocasionais e/ou sobrevoantes – $FO < 15\%$ (Mendonça-Lima e Fontana 2000).

A fim de verificar a variação na composição de espécies nas diferentes estações de amostragem, os dados de presença e abundância das espécies foram ordenados pelo escalonamento multidimensional não métrico (nMDS). A similaridade entre os ambientes foi determinada utilizando o índice de Jaccard. Esses cálculos também foram efetuados no programa PAST 4.12 (Hammer 2001).

RESULTADOS E DISCUSSÃO

Na Estação Ecológica Municipal Paulo Pinto de Oliveira foram registradas 116 espécies de aves distribuídas em 43 famílias (tabela 1), o que representa aproximadamente 15% da avifauna existente no estado. Dados atualizados do ano de 2023 baseado em registros visuais (observações e fotos) e sonoros do mapa interativo do site WIKIAVES tem revelado a ocorrência de 737 espécies de aves no Paraná. Considerando o tamanho do fragmento florestal, esse dado é relevante, e mostra como esses biomas são importantes para manter a estabilidade da avifauna com uma boa capacidade de suporte.

Os dados de frequência de ocorrência geral para determinar a forma de ocupação do habitat revelaram que 22 espécies foram consideradas residentes, 47 prováveis residentes e 47 espécies ocasionais. Aproximadamente 60% das espécies registradas na EEMPPO apresentam um alto grau de dependência dos recursos lá existentes e exploram a área da estação ecológica como lar fixo, desenvolvendo habitualmente as atividades de forrageamento e reprodução.

Usando como base os dados de Ridgely et al. (2015) foi possível verificar que das espécies registradas, nenhuma delas é apontada em caráter de criticamente em perigo, em perigo ou vulnerável. Muito provável que o número de espécies neste fragmento seja ainda maior e existam espécies com alto grau de endemismo para a região, o que não pode ser detectado devido ao período de estudo ser fortemente marcado por interferências climáticas atípicas para a época, como o frio e chuvas.

Aves ameaçadas exibem comportamentos crípticos, e uma das metodologias consideradas mais adequada ao registro seria o uso dos 'playbacks', o que não foi usado no presente trabalho. Essa metodologia utiliza sons gravados do canto e outros tipos de vocalizações de espécies raras e ameaçadas, para induzir uma resposta "feedback" e registrar sua ocorrência, residência, riqueza e distribuição na área (González-García 2011). Muitos ornitólogos discutem sobre o nível de interferência (período reprodutivo) que esses sistemas podem ocasionar na avifauna, especialmente partindo do pressuposto que numa investigação inicial não se sabe ao certo qual a composição da fauna. Outro ponto importante é que o período estudado abrangeu pequena parcela dos meses que tradicionalmente ocorrem o incremento da fauna de aves por atividade migratória, usualmente no final de setembro (início da primavera) e final de março (início do outono).

A vegetação nativa da EEMPPO é semelhante a do fragmento florestal do Parque do Ingá, pertencente ao Sistema Nacional de Unidades de Conservação, na cidade de Maringá (PR). Na vegetação estacional semidecidual dessa unidade predominam espécies vegetais como *Aspidosperma polyneuron* (peroba-rosa), *Balfourodendron riedelianum* (pau-marfim), *Cariniana estrellensis* (jequitibá-branco), *Cedrela fissilis* (cedro-rosa), *Euterpe edulis* (palmeira-juçara), *Gallesia integrifolia* (pau-d'alho), *Holocalyx balansae* (pau-alecrim), *Jacaratia spinosa* (jaracatiá) e *Peltophorum dubium* (barbatimão). Estudos realizados por Galina e Gimenes (2006) nesse local, mostraram que há uma sensível redução do número e frequência de espécies quando é avaliado o comportamento das aves entre o interior da floresta e margem do lago. É provável que comparações entre a avifauna de borda e do núcleo da EEMPPO resultem em comportamentos similares, em função da distribuição das espécies vegetais e fitofisionomias observadas. A diversidade e densidade da avifauna é fortemente influenciada pela composição de espécies vegetais, tamanho da área de vegetação e até mesmo pela arquitetura vegetal. Em ambientes com presença de eucalipto, por exemplo, não se observam aves florestais, porque esse tipo de vegetação representa barreiras ao estabelecimento das linhas de voo (Dário et al. 2002). O relato anterior demonstra como a vegetação pode interferir na ocorrência de espécies de aves em determinados locais, criando uma identidade da avifauna intrinsecamente relacionadas às características fitofisionômicas. A Floresta Nacional de Irati (3.802 ha), composta por vegetação de campos antrópicos, florestamentos homogêneos, e remanescentes de Floresta Ombrófila Mista em bom estado de conservação, abriga 81 espécies de aves, sendo 40 com hábitos predominantemente florestais (Marcelino e Romaniuk 2010). Esses dados demonstram que até mesmo pequenos fragmentos florestais são capazes de dar suporte a uma quantidade significativa de aves, servindo como locais seguros para forrageamento e reprodução.

Tabela 1. Registro de espécies de Aves e frequência de ocorrência (FO%) nos pontos de amostragem na Estação Ecológica Municipal Paulo Pinto de Oliveira durante o período de março a maio de 2022.

Famílias	Espécies	Estações de Amostragem										FO (%)
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
Tinamidae	<i>Crypturellus obsoletus</i> (Temminck, 1815)	X	X	X	X			X	X	X		70
(Gray, 1840)	<i>Crypturellus tataupa</i> (Temminck, 1815)							X				10
Anatidae	<i>Amazonetta brasiliensis</i> (Gmelin, 1789)				X			X				20
(Leach, 1820)	<i>Penelope obscura</i> (Temminck, 1815)					X				X		20
Odontophoridae	<i>Odontophorus capueira</i> (Spix, 1825)									X		10
Columbidae	<i>Patagioenas picazuro</i> (Temminck, 1813)	X	X	X	X	X	X	X	X		X	90
(Leach, 1820)	<i>Patagioenas cayennensis</i> (Bonaterre, 1792)					X	X	X	X			40
	<i>Patagioenas plumbea</i> (Vieillot, 1818)								X			10
	<i>Leptotila verreauxi</i> (Bonaparte, 1855)			X	X	X			X	X	X	60
	<i>Zenaida auriculata</i> (Des Murs, 1847)	X	X	X	X	X						50
	<i>Columbina talpacoti</i> (Temminck, 1811)		X		X		X					30
	<i>Columbina squammata</i> (Lesson, 1831)		X								X	20
Cuculidae	<i>Guira guira</i> (Gmelin, 1788)					X						10
(Leach, 1820)	<i>Crotophaga ani</i> (Linnaeus, 1758)							X				10
	<i>Tapera naevia</i> (Linnaeus, 1766)				X			X				20
	<i>Dromococcyx phasianellus</i> (Spix, 1824)	X										10
	<i>Piaya cayana</i> (Linnaeus, 1766)				X					X		20
Nyctibiidae	<i>Nyctibius griseus</i> (Gmelin, 1789)			X				X				20
(Chenu & Des Murs, 1851)												
Trochilidae	<i>Phaethornis pretrei</i> (Lesson & Delattre, 1839)					X						10
(Vigors, 1825)												10
	<i>Chlorostilbon lucidus</i> (Shaw, 1812)	X										10
	<i>Chrysuronia versicolor</i> (Vieillot, 1818)				X							10
	<i>Leucochloris albicollis</i> (Vieillot, 1818)	X	X									30
Rallidae	<i>Aramides cajaneus</i> (Statius Muller, 1776)	X				X	X					30
(Rafinesque, 1815)												
	<i>Aramides saracura</i> (Spix, 1825)	X										10
Charadriidae	<i>Vanellus chilensis</i> (Molina, 1782)		X	X	X	X	X	X	X		X	80
(Leach, 1820)												
Recurvirostridae	<i>Himantopus mexicanus</i> (Statius Muller, 1776)			X	X	X						30
(Bonaparte, 1831)												
Scolopacidae	<i>Calidris alba</i> (Pallas, 1764)							X				10
(Rafinesque, 1815)	<i>Tringa solitaria</i> (Wilson, 1813)							X				10
	<i>Tringa melanoleuca</i> (Gmelin, 1789)				X							10
	<i>Tringa flavipes</i> (Gmelin, 1789)				X							10

...continua

Tabela 1. Continuação

Família	Espécie	Estações de Amostragem										FO %	
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		
Phalacrocoracidae (Reichenbach, 1849)	<i>Nannopterum brasilianum</i> (Gmelin, 1789)	X	X	X	X		X						40
Ardeidae (Leach, 1820)	<i>Butorides striata</i> (Linnaeus, 1758)	X	X	X									30
	<i>Ardea cocoi</i> (Linnaeus, 1766)	X			X		X	X				X	50
	<i>Ardea alba</i> (Linnaeus, 1758)	X	X	X	X		X	X		X		X	80
	<i>Egretta thula</i> (Molina, 1782)	X	X	X	X		X						50
Threskiornithidae (Poche, 1904)	<i>Mesembrinibis cayennensis</i> (Gmelin, 1789)	X											10
	<i>Theristicus caudatus</i> (Boddaert, 1783)						X						10
Cathartidae (Lafresnaye, 1839)	<i>Sarcoramphus papa</i> (Linnaeus, 1758)								X				10
	<i>Coragyps atratus</i> (Bechstein, 1793)				X				X				20
	<i>Cathartes aura</i> (Linnaeus, 1758)	X	X	X	X		X	X					60
Pandionidae (Bonaparte, 1854)	<i>Pandion haliaetus</i> (Linnaeus, 1758)				X	X	X						30
Accipitridae (Vigors, 1824)	<i>Spizaetus tyrannus</i> (Wied, 1820)				X								10
	<i>Accipiter striatus</i> (Vieillot, 1808)										X		10
	<i>Urubitinga urubitinga</i>	X											10
	<i>Rupornis magnirostris</i>		X	X	X	X	X	X	X	X	X	X	90
Trogonidae (Lesson, 1828)	<i>Trogon surrucura</i> (Vieillot, 1817)	X					X		X	X	X	X	30
	<i>Trogon chrysochloros</i> (Pelzeln, 1856)								X	X			20
Alcedinidae (Rafinesque, 1815)	<i>Megaceryle torquata</i> (Linnaeus, 1766)	X	X	X	X	X	X	X	X	X	X	X	100
	<i>Chloroceryle amazona</i> (Latham, 1790)	X	X	X	X	X	X					X	70
	<i>Chloroceryle americana</i> (Gmelin, 1788)	X	X	X									30
Ramphastidae (Vigors, 1825)	<i>Ramphastos dicolorus</i> (Linnaeus, 1766)								X	X	X		30
Picidae (Leach, 1820)	<i>Melanerpes flavifrons</i> (Vieillot, 1818)						X						10
	<i>Veniliornis spilogaster</i> (Wagler, 1827)	X			X			X		X			40
	<i>Dryocopus lineatus</i> (Linnaeus, 1766)	X						X					20
Falconidae (Leach, 1820)	<i>Caracara plancus</i> (Miller, 1777)				X			X				X	20
	<i>Milvago chimachima</i> (Vieillot, 1816)	X	X					X					30
	<i>Falco sparverius</i> (Linnaeus, 1758)	X	X	X									30
Psittacidae (Rafinesque, 1815)	<i>Psittacara leucophthalmus</i> (Statius Muller, 1776)				X	X	X	X	X	X	X	X	70
Thamnophilidae (Swainson, 1824)	<i>Thamnophilus doliatus</i> (Linnaeus, 1764)				X	X							20
	<i>Dysithamnus mentalis</i> (Temminck, 1823)								X				10

...continua

Tabela 1. Continuação

Família	Espécie	Estações de Amostragem										FO %	
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		
Thamnophilidae (Swainson, 1824)	<i>Herpsilochmus rufimarginatus</i> (Temminck, 1822)					X							10
	<i>Thamnophilus ruficapillus</i> (Vieillot, 1816)						X						10
	<i>Drymophila rubricollis</i> (Bertoni, 1901)			X									10
Dendrocolaptidae (Gray, 1840)	<i>Sittasomus griseicapillus</i> (Vieillot, 1818)								X		X		20
	<i>Furnarius rufus</i> (Gmelin, 1788)					X							10
Furnariidae (Gray, 1840)	<i>Synallaxis cinerascens</i> (Temminck, 1823)	X		X	X				X	X		X	60
	<i>Synallaxis spixi</i> (Sclater, 1856)		X			X	X	X	X	X		X	60
	<i>Carpornis cucullata</i> (Swainson, 1821)	X											10
Tityridae (Gray, 1840)	<i>Tityra cayana</i> (Linnaeus, 1766)				X								10
	<i>Pachyrhamphus polychopterus</i> (Vieillot, 1818)				X								10
Rhynchocyclidae (Berlepsch, 1907)	<i>Mionectes rufiventris</i> (Cabanis, 1846)									X			10
Tyrannidae (Vigors, 1825)	<i>Camptostoma obsoletum</i> (Temminck, 1824)	X	X									X	30
	<i>Elaenia mesoleuca</i> (Deppe, 1830)											X	10
	<i>Myiopagis viridicata</i> (Vieillot, 1817)			X									10
	<i>Legatus leucophaeus</i> (Vieillot, 1818)					X							10
	<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	X	X	X	X	X	X	X	X	X	X	X	100
	<i>Myiodynastes maculatus</i> (Stadius Muller, 1776)	X	X	X									30
	<i>Megarynchus pitangua</i> (Linnaeus, 1766)	X	X	X	X				X			X	60
	<i>Myiozetetes similis</i> (Spix, 1825)					X							10
	<i>Tyrannus melancholicus</i> (Vieillot, 1819)	X	X	X									30
	<i>Lathrotriccus euleri</i> (Cabanis, 1868)				X								10
	<i>Contopus cinereus</i> (Spix, 1825)			X									10
	<i>Cyclarhis gujanensis</i> (Gmelin, 1789)				X		X	X					30
	Vireonidae (Swainson, 1837)	<i>Vireo chivi</i> (Vieillot, 1817)							X			X	
<i>Cyanocorax chrysops</i> (Vieillot, 1818)									X			X	20
Corvidae (Leach, 1820)	<i>Stelgidopteryx ruficollis</i> (Vieillot, 1817)			X									10
Hirundinidae (Rafinesque, 1815)	<i>Tachycineta albiventer</i> (Boddaert, 1783)	X	X	X	X				X			X	70
	<i>Troglodytes musculus</i> (Naumann, 1823)		X	X		X				X		X	60
Troglodytidae (Swainson, 1831)	<i>Ramphocaenus melanurus</i> (Vieillot, 1819)								X				10
Poliophtidae (Baird, 1858)	<i>Poliophtila dumicola</i> (Vieillot, 1817)					X							10

...continua

Tabela 1. Continuação

Família	Espécie	Estações de Amostragem										FO %
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
Turdidae (Rafinesque, 1815)	<i>Turdus leucomelas</i> (Vieillot, 1818)						X		X	X		30
	<i>Turdus rufiventris</i> (Vieillot, 1818)			X	X	X		X	X	X	X	70
	<i>Turdus amaurochalinus</i> (Cabanis, 1850)							X	X			20
	<i>Turdus albicollis</i> (Vieillot, 1818)						X					10
Mimidae (Bonaparte, 1853)	<i>Mimus saturninus</i> (Lichtenstein, 1823)					X						10
Fringillidae (Leach, 1820)	<i>Euphonia chlorotica</i> (Linnaeus, 1766)					X		X				20
Passerellidae (Cabanis & Heine, 1850)	<i>Ammodramus humeralis</i> (Bosc, 1792)							X				10
	<i>Zonotrichia capensis</i> (Statius Muller, 1776)	X	X	X	X	X	X	X	X	X	X	100
Icteridae (Vigors, 1825)	<i>Psarocolius decumanus</i> (Pallas, 1769)								X			10
	<i>Gnorimopsar chopi</i> (Vieillot, 1819)				X							10
Parulidae (Wetmore, Friedmann, Lincoln, Miller, Peters, van Tyne & Zimmer, 1947)	<i>Geothlypis aequinoctialis</i> (Gmelin, 1789)		X		X	X						30
	<i>Setophaga pitiayumi</i> (Vieillot, 1817)				X	X	X	X	X	X	X	70
	<i>Myiothlypis leucoblephara</i> (Vieillot, 1817)	X	X	X	X	X	X	X	X	X	X	100
	<i>Basileuterus culicivorus</i> (Deppe, 1830)	X	X	X	X	X	X	X	X	X	X	100
Thraupidae (Cabanis, 1847)	<i>Hemithraupis guira</i> (Linnaeus, 1766)						X		X			20
	<i>Dacnis cayana</i> (Linnaeus, 1766)					X	X					20
	<i>Saltator similis</i> (d'Orbigny & Lafresnaye, 1837)		X	X	X	X		X	X		X	70
	<i>Coereba flaveola</i> (Linnaeus, 1758)				X						X	20
	<i>Volatinia jacarina</i> (Linnaeus, 1766)	X	X	X	X	X	X	X				70
	<i>Trichothraupis melanops</i> (Vieillot, 1818)						X		X			10
	<i>Coryphospingus cucullatus</i> (Statius Muller, 1776)		X		X	X	X	X				40
	<i>Tachyphonus coronatus</i> (Vieillot, 1822)					X	X					20
	<i>Sporophila caerulescens</i> (Vieillot, 1823)			X								10
	<i>Conirostrum speciosum</i> (Temminck, 1824)								X			10
	<i>Sicalis flaveola</i> (Linnaeus, 1766)				X	X	X	X	X			50
	<i>Thraupis sayaca</i> (Linnaeus, 1766)				X		X					20
No de famílias:				43								
No de espécies:				116								

Os dados de abundância (figura 2) revelaram que as estações P1 e P6 (220 e 347 indivíduos registrados) foram as que apresentaram maior número de contatos com espécies de aves. Por outro lado, nos extremos da estação o número de indivíduos nos P9 e P10 (69 e 92 indivíduos) foi bem menor. As estações de amostragem com distribuição intermediária na borda apresentaram a abundância variando entre 103 a 161 indivíduos. Os pontos 9 e 10 onde foram registrados a menor número de contatos apresentaram abundância significativamente menor do que as outras estações de amostragem.

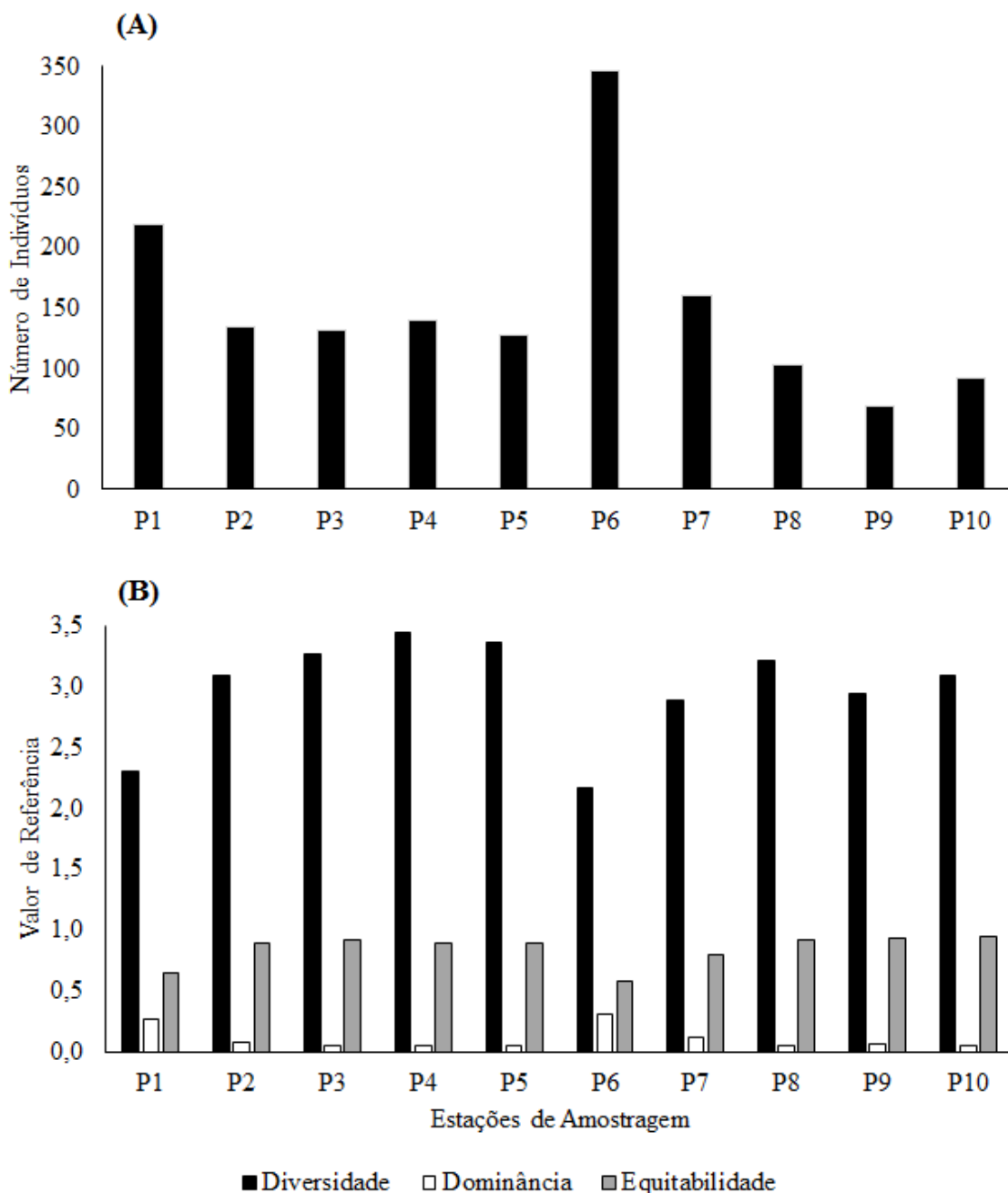


Figura 2. Dados quantitativos e qualitativos de espécies de aves registradas na estação Paulo Pinto de Oliveira (A) Abundância e (B) Diversidade de Shannon-Winner, Dominância de Simpson e Equitabilidade de Pielou.

Em relação à diversidade observou-se que os pontos P1 e P6 foram os que apresentaram os menores valores de diversidade. Nesses locais a composição de espécies foi relativamente diferente

em relação às demais. Também foram detectadas algumas diferenças na composição faunística para estações que ficam em posição mediana na borda. Esses resultados permitem deduzir que quanto mais próximo forem os ambientes e quanto mais similares forem suas composições fitofisionômicas, maior a probabilidade de similaridade entre o registro de espécies.

As espécies mais abundantes e representativas para o fragmento foram o *Nannopterum basilianum* (biguá), *Psittacara leucophthalmus* (maritaca), *Zonotrichia capensis* (tico-tico), *Pitangus sulphuratus* (bem-te-vi), *Ardea alba* (garça-branca-grande), *Megaceryle torquata* (martim-pescador-grande), *Myiothlypis leucoblephara* (pula-pula-assobiador) e *Basileuterus culicivorus* (pula-pula). Fauna esta composta por aves de hábitos variados que identificam o efeito de borda da zona limítrofe a planície de inundação do Rio Iguaçu. Como ocorreram períodos notadamente marcados de cheias e secas ao longo das amostragens, que interferiram no nível do rio, observaram-se também a ocorrência de espécies com hábitos de exploração de áreas abertas, áreas alagadas, capoeiras, borda de mata e dossel de árvores.

O índice de ocupação de habitat por repartição das estações de amostragem (figura 3) mostrou que as aves apresentam comportamentos distintos em cada ponto. Algumas espécies demonstram uma preferência por um determinado local, sendo classificadas como residentes e prováveis residentes. Por outro lado, um percentual considerável de espécies habita os diferentes locais da estação de maneira ocasional. Esses dados sugerem que muitas espécies migram de um lado para o outro para executarem o forrageamento, e outras preferem ficar instaladas num determinado local.

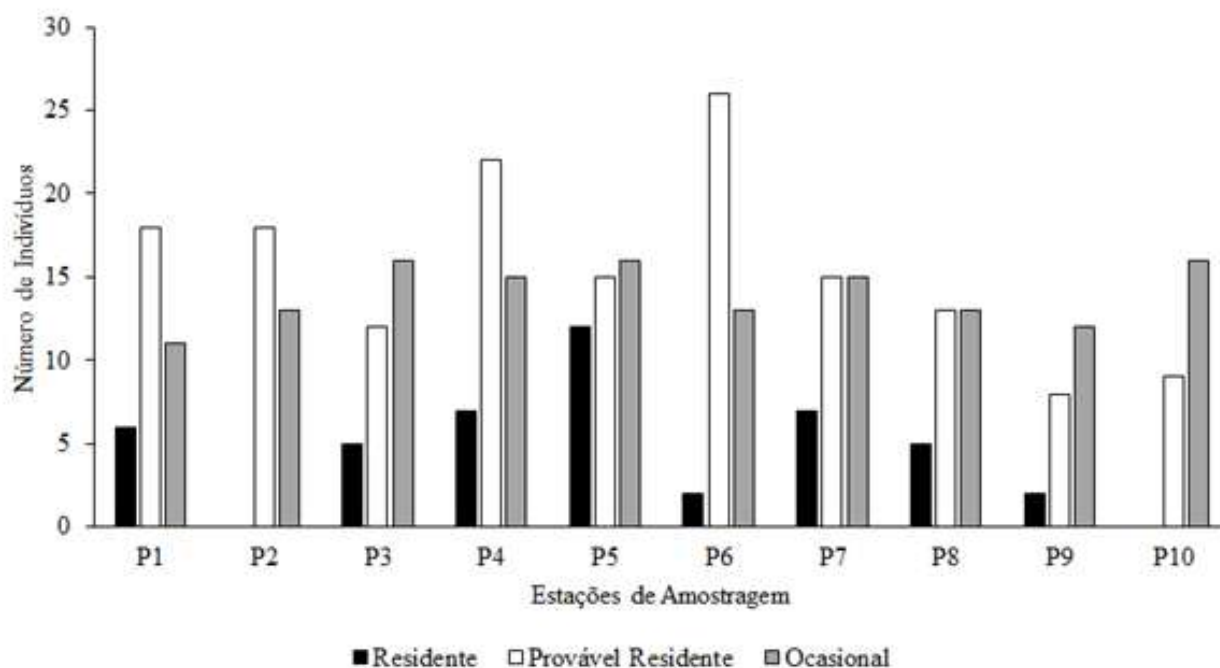


Figura 3. Índice de ocupação de espécies de aves nos locais amostrados na estação Paulo Pinto de Oliveira.

Durante as expedições para as amostragens dos pontos 1 e 2, as médias de temperatura estavam em torno de 25°C e havia uma faixa razoável de borda limitando o ecótono floresta/água. A partir do período de amostragens do ponto 4 ao ponto 6 observou-se uma queda gradual da média de temperatura e a borda da margem manteve-se ainda visível, com exposição de áreas alagadas,

capoeiras e palafitas. Justamente nesse período, mesmo com as médias de temperaturas mais baixas observou-se um aumento do número de contatos com as espécies de aves migratórias ou residentes na estação. Esse fato pode estar relacionado a complexidade que as bordas limítrofes ao rio Iguaçu criam, disponibilizando maior quantidade de abrigos contra predadores, oferta variada de alimento e locais mais apropriados para nidificação, especialmente para espécies com comportamento anfíbio. Fortes indícios mostram como as áreas de borda de planícies de inundação aumentam a complexidade estrutural de nichos e o intercâmbio de espécies de aves. Loures-Ribeiro e Anjos (2015) por exemplo, demonstraram que para aves raptorais a diversificação de habitats na borda de áreas alagáveis com interferências na estruturação de campo/pastagem e várzea, podem ser fatores significativos para explicar a variação de ocorrência de espécies de Falconiformes.

A figura 4 mostra o número de contatos em função do número de espécies registradas na estação e observa-se uma tendência temporal a diminuição do número de contatos com espécies de aves. As estações P4, P5, P6 e P7 foram as que apresentaram o maior número de contatos registrados.

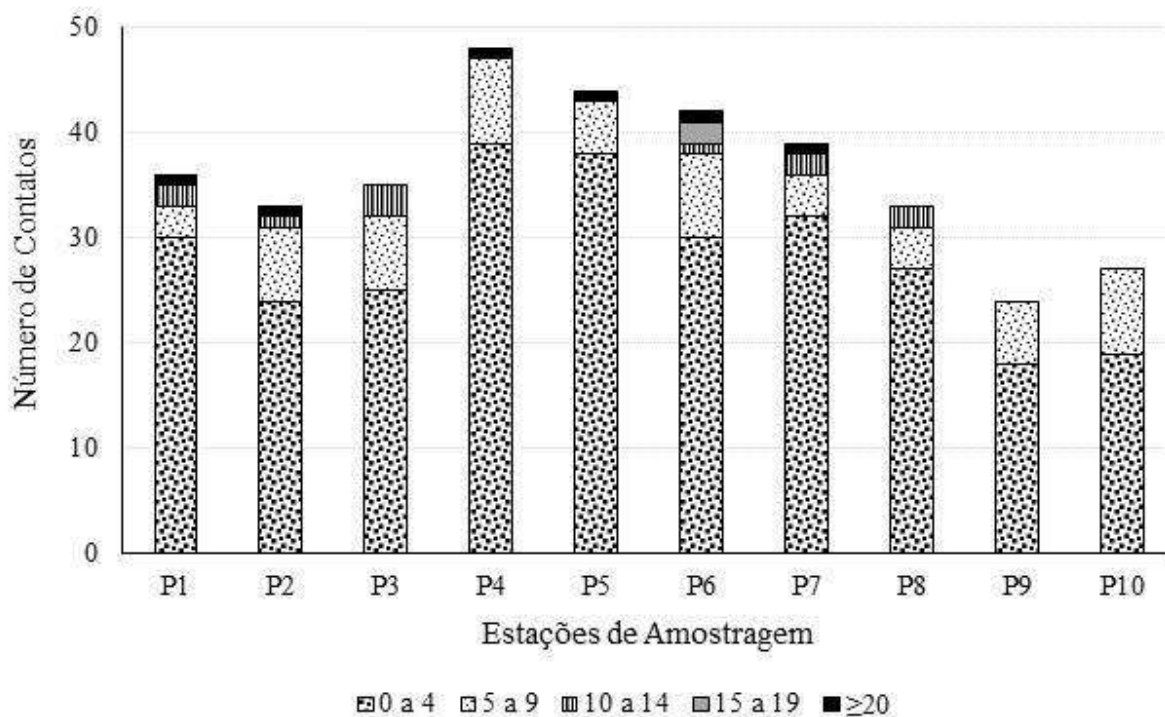


Figura 4. Número de contatos com espécies de Aves nas estações de amostragem da unidade de proteção integral em função do número de espécies registradas de acordo com a abundância.

Nunes e Tomas (2004) sustentam a ideia de que áreas de vegetação associadas a planícies de inundação correspondem a sítios de invernada para várias espécies de aves, tanto migratórias como residentes. Segundo esses autores o inverno tem impactos na distribuição de aves, por modificar a oferta de recursos alimentares obrigando as aves a procurar os sítios de invernada. Assim, os fragmentos florestais em determinados períodos do ano podem ter um incremento de espécies, que buscam esses locais com fartura de alimento, para garantia de engorda e aquisição de energia para troca da plumagem, postura, nidificação, ou retorno a sítios reprodutivos.

Investigações realizadas por Franchin et al. (2011) numa área de vegetação ripária do Cerrado na Usina Hidrelétrica de Jaguara (MG) mostraram que diferentes fitofisionomias associadas a presença de corpos d'água contribuem para sustentar maior diversidade de espécies. Assim podem ser registradas aves típicas de ambientes campestres, florestais e aquáticos ao mesmo

tempo. Em nossos resultados, o número de contatos tende a cair com a cheia do rio Iguazu, o que coincidiu com os períodos de amostragens dos pontos 8, 9 e 10, e isso provavelmente está associado à limitação de recursos imposta para a região de borda. Além disso, as temperaturas registradas nesse período variaram de 2 a 6 °C intercaladas com momentos de geada, o que também dificultou o contato com aves, que nessas condições permanecem intocadas.

Dentre os hábitos alimentares predominantes na EEMPPPO foram representados pelas aves onívoras (25%), insetívoras (25%) e piscívoras (19,4%) indicados na figura 5. Cabe aqui salientar as aves que dependem quase que exclusivamente dos peixes em sua dieta, entre elas *Megaceryle torquata* (martim-pescador-grande), *Chloroceryle americana* (martim-pescador-pequeno), *Chloroceryle amazona* (martim-pescador-verde), *Egretta thula* (garça-branca-pequena), *Ardea cocoi* (garça-moura), *Butorides striata* (socozinho), *Pandion haliaetus* (águia-pescadora), *Nannopterum brasilianum* (biguá). Essas espécies estão intimamente ligadas com a mata ciliar e o Rio Iguazu, assim como suas oscilações com as secas e as cheias, dependendo das condições e recursos do ambiente.

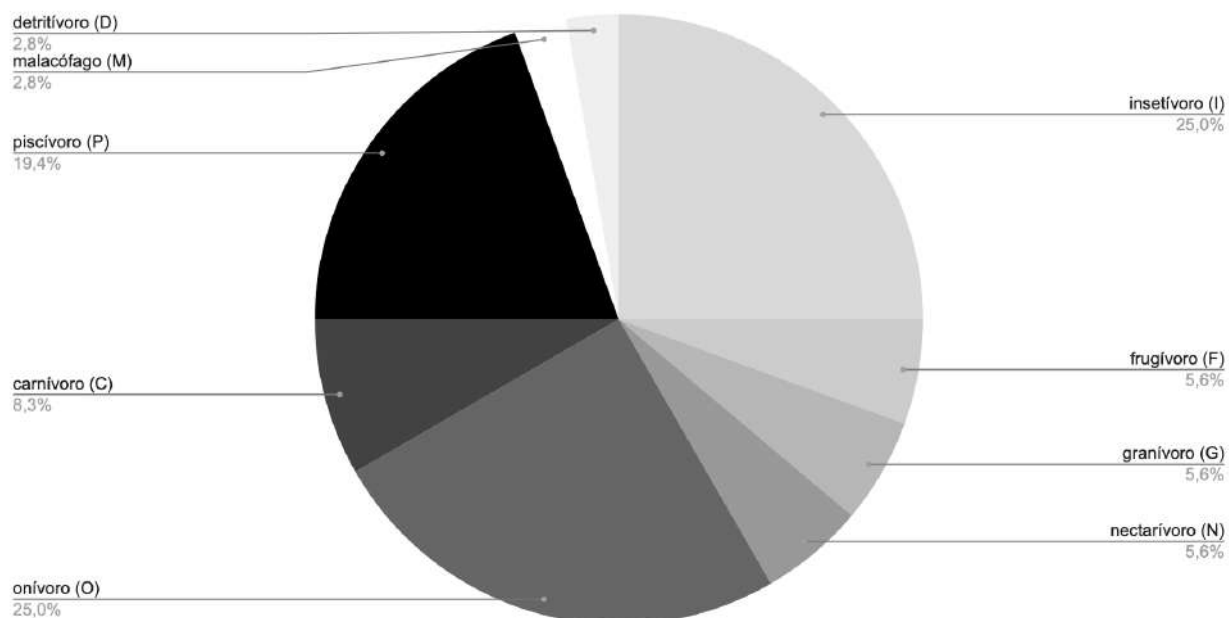


Figura 5. Guildas Tróficas e sua distribuição em porcentagem na EEMMPO.

Os dados de abundância registrados nos pontos foram submetidos à análise de agrupamento Non metric-MDS (NMDS), por parâmetro de Jaccard, formando grupos de similaridade (figura 6). No Ponto 1 foram registrados 36 táxons, e o Índice Pontual de Abundância variou de 0,028 (1 contato) a 3,056 (110 contatos), resultando num total de 6,111 (220 contatos). O Índice de diversidade de Shannon-Winner calculado para essa região foi de 2,389, e observou-se que os insetívoros e onívoros foram os hábitos alimentares predominantes, com 9 representantes em cada guilda. Nesse ponto, ocorreu a presença de 110 representantes da espécie piscívora *Nannopterum brasilianum* (biguá), resultando em um índice de dominância de Simpson elevado de 0,2598, o que acreditou-se contribuir para manter o ponto isolado dos demais em questão de similaridade.

Observado na zona limítrofe na Estação Ecológica, o Ponto 1 está situado num local de mata ciliar secundária, com formações rochosas, em confluência com um rio tributário de ordem secundária menor que deságua no rio Iguazu. As observações foram feitas próximas a lage de rochas, com a borda acidentada e presença de pedregulhos. As aves *Mesembrinibis cayennensis* (coró-coró), *Dromococcyx phasianellus* (peixe-frito), *Carpornis cucullata* (corocoxó), *Aramides*

saracura (saracura-do-mato), *Urubitinga urubitinga* (gavião-preto) e *Chlorostilbon lucidus* (besourinho-de-bico-vermelho) foram registradas somente nesse ponto, sendo as aves residentes locais. De acordo com Sick (1997), *M. cayennensis* é o único representante florestal da família Threskiornithidae, e é encontrado em matas úmidas e escuras. *Dromococcyx phasianellus* é uma espécie que nidifica nos ninhos de outras aves, geralmente passeriformes, o ovo da espécie é mimético com das outras aves, e eclodem antes dos anfitriões, podendo matá-los para garantir seu alimento. *Carponis cucullata* é uma espécie endêmica do Brasil, considerada pelos ornitólogos incomum porque é mais ouvida do que vista. *Aramides saracura* é encontrada em florestas alagadas e terrenos acidentados, possui hábito onívoro se alimentando até mesmo de ovos de outras aves. *Urubitinga urubitinga* nidifica a margem de rios, sendo mais possível observá-lo nesses locais. A espécie de beija-flor *C. lucidus* é uma das mais comuns da família Trochilidae, com hábito alimentar nectarívoro e frequentando ambientes com capoeiras ralas.

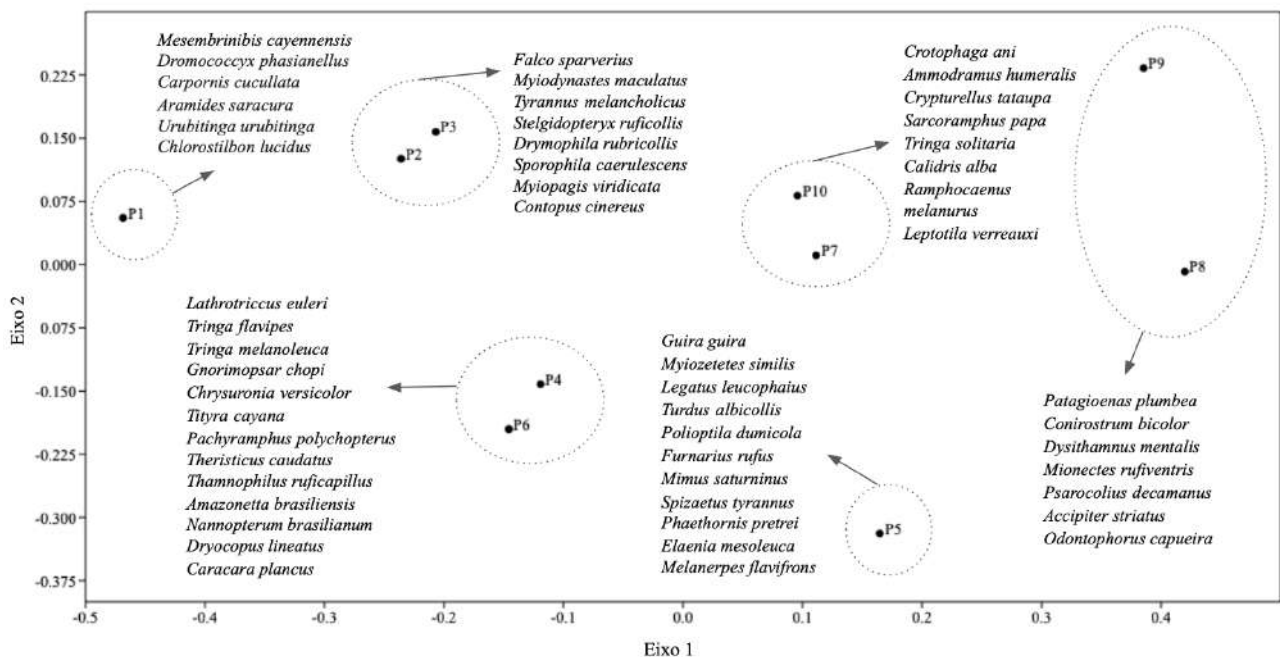


Figura 6. Agrupamentos por escalonamento multidimensional não métrico (nMDS) e por similaridade de Jaccard nas estações de amostragem da EEMPPO.

O segundo e terceiro ponto de amostragem (P2 e P3) foram agrupados por similaridade levando em consideração a riqueza de espécies pelo teste de ordenação Non Metric MDS (parâmetro de Jaccard). No Ponto 2 foram registrados 33 táxons, com Índice Pontual de Abundância variando entre 0.030 (1 contato) e 0.788 (26 contatos), somando em 4.061 (134 contatos). O Índice de diversidade calculado foi de 3.217, e a dominância de 0.062 e o hábito alimentar predominante insetívoro e onívoro, com 8 representantes para cada guilda. No terceiro ponto ocorreram 35 táxons, o Índice Pontual de Abundância variou de 0.028 (1 contato) a 0.40 (14 contatos), somando em 3.771 (132 contatos). O índice de diversidade deste ponto foi 3.395 e a dominância 0.041, com espécies de hábito alimentar predominantemente insetívoro, com 12 representantes, e onívoro com 8 representantes. No segundo e no terceiro ponto observou-se uma fitofisionomia F3, onde a floresta secundária na margem do rio estava em estado de regeneração, com a presença de espécies vegetais exóticas como por exemplo *Citrus bigaradia*, *Pinus elliotti* e bambu (várias espécies). Nesses dois pontos foram observadas seis espécies piscívoras, dentre elas *Chloroceryle americana* (martim-pescador-pequeno) de hábito aquático, que constrói seu ninho nos barrancos às margens dos rios; e *Butorides striata* (socozinho) que vive solitário em ambientes com água. As duas espécies não foram avistadas nos pontos seguintes. Percebeu-se que as espécies *Falco sparverius*

(quiriquiri), *Myiodynastes maculatus* (bem-te-vi-rajado) e *Tyrannus melancholicus* (suiriri) ponto 2 e 3 tiveram peso entre os pontos 2 e 3, sendo estas espécies que habitam áreas abertas.

O ponto 3 apresentou as aves *Stelgidopteryx ruficollis* (andorinha-serradora), *Drymophila rubricollis* (choquinha-dublê), *Sporophila caerulescens* (coleirinho), *Myiopagis viridicata* (guaracava-de-crista-alaranjada) e *Contopus cinereus* (papa-moscas-cinzeno) como residentes locais. *Stelgidopteryx ruficollis* é comumente encontrada próxima a água, empoleirando-se em galhos secos nos rios e construindo seu ninho nos buracos de barrancos. *Drymophila rubricollis* ocorre primariamente no Brasil, sendo considerada uma espécie quase endêmica, ela é encontrada em capoeiras, borda de mata e facilmente associada a formações de taquaras e bambus. *Sporophila caerulescens* é mais comum em áreas abertas onde há capinzais para fornecer seu alimento. *Myiopagis viridicata* e *C. cinereus* vivem nas bordas de mata e capoeira. Percebe-se aqui a quantidade de interações ecológicas que essas espécies podem desenvolver nas áreas de borda, o que explica sua ocorrência como residentes.

O ponto 4 e o ponto 6 foram agrupados em função do peso das espécies *Theristicus caudatus* (curucaca), *Thamnophilus ruficapillus* (choca-de-chapéu-vermelho), *Amazonetta brasiliensis* (marreca-ananai), *Nannopterum brasilianum* (biguá), *Dryocopus lineatus* (pica-pau-de-banda-branca), *Tityra cayana* (anambé-branco-de-rabo-preto) e *Caracara plancus* (carcará). Os dois pontos foram marcados pela presença da fitofisionomia F4, com vegetação nativa e áreas úmidas de floresta estacional semidecidual, às margens do lago, porém um pouco esparsa se comparada à floresta clímax.

O ponto 4 apresentou o maior número de táxons com 48 espécies, o maior índice de diversidade com 3.617, além de apresentar o segundo maior número de prováveis residentes observados, totalizando 22 espécies. O índice pontual de abundância deste ponto variou de 0.021 (1 contato) e 0.417 (20 contatos), possuindo resultado de soma 2.917 (140 contatos), com dominância baixa de 0.040. As espécies de aves residentes locais foram *Lathrotriccus euleri* (enferrujado), *Tringa flavipes* (maçarico-de-perna-amarela), *Tringa melanoleuca* (maçarico-grande-de-perna-amarela), *Gnorimopsar chopi* (pássaro-preto), *Chrysuronia versicolor* (beija-flor-de-banda-branca), *Tityra cayana* (anambé-branco-de-rabo-preto), e *Pachyramphus polychopterus* (caneleiro-preto). *Lathrotriccus euleri* é encontrado em borda de mata e capoeiras, presente em nossa região principalmente no verão, pois durante o inverno migra para outras regiões mais quentes do Brasil. *Tringa flavipes* e *T. melanoleuca* vivem nos lagos e rios, além de habitarem o litoral sendo aves migratórias. *Gnorimopsar chopi* é comum em remanescentes florestais, áreas pantanosas e abertas. *Chrysuronia versicolor* é encontrado em capoeiras e bordas de matas úmidas. *Tityra cayana* é visível na copa das árvores, nas bordas de mata e capoeiras. *Pachyramphus polychopterus* vive na borda de mata, nidificando em árvores altas isoladas.

No ponto 6 o Índice Pontual de Abundância variou de 0.024 (1 contato) a 4.52 (190 contatos) resultando em 8.26 (347 contatos). Esse ponto foi marcado por uma alta dominância, no valor de 0.309, devido a presença de uma grande quantidade de *Nannopterum brasilianum* (biguá). Essa espécie vive em rios e áreas alagadas alimentando-se dos peixes, e na EEMPPO observou-se que ela utiliza-se frequentemente os poleiros expostos (palafitas) durante as secas do Rio Iguaçu, para nidificar e encontrar abrigo. Um hábito observado da espécie é que ela mergulha para se alimentar, e nas horas mais quentes abre suas asas para secar suas penas nos poleiros.

Apenas 2 espécies foram enquadradas como residentes no ponto 6, e cabe ressaltar que nesse local encontramos o maior número de prováveis residentes locais, totalizando 26 espécies. As aves residentes locais foram *Theristicus caudatus* (curucaca) e *Thamnophilus ruficapillus*

(choca-de-chapéu-vermelho), a primeira possui o hábito de ocupar locais abertos e alagados, e a segunda borda de mata e capoeira.

O ponto 5 ficou isolado dos demais pontos, com o Índice Pontual de Abundância variando de 0.023 (1 contato) a 0.455 (20 contatos) resultando em um total de 2.91 (128 contatos), a dominância ficou em 0.046 e a fitofisionomia enquadrada como F4, com características de áreas úmidas e capoeiras de vegetação nativa. No ponto 5 foram registradas 12 espécies agrupadas como residentes locais, entre elas *Guira guira* (anu-branco), *Myiozetetes similis* (bentevizinho-de-penacho-vermelho), *Legatus leucophaeus* (bem-te-vi-pirata), *Turdus albicollis* (sabiá-coleira) *Poliophtila dumicola* (balança-rabo-de-máscara) que são encontrados em mata de borda e capoeiras. Já as espécies residentes *Furnarius rufus* (joão-de-barro) e *Mimus saturninus* (sabiá-do-campo) exploram mata de borda e áreas abertas. Tanto o *Spizaetus tyrannus* (gavião-pega-macaco) que é uma ave de rapina florestal, quanto *Phaethornis pretrei* (beija-flor-de-rabo-branco-acanelado) possuem uma alta afinidade com matas ciliares e florestas úmidas, e foram classificados como residentes locais. Esse fato pode estar relacionado a fitofisionomia característica, que cria condições de suporte dessas espécies por aumento de recursos específicos, presas e fontes de néctar. As espécies *Elaenia mesoleuca* (tuque) e *Melanerpes flavifrons* (benedito-de-testa-amarela) observadas nesse ponto, são consideradas praticamente endêmicas. Esse é um dado muito relevante, pois dá suporte a ideia de que a EEMPPPO, pode ser um fragmento importante para recrutamento de espécies raras.

O escalonamento multidimensional mostrou que 8 espécies de aves tiveram maior peso para agrupar os pontos 7 e 10. A fitofisionomia dos dois pontos foi condizente com F5, característico de floresta clímax. O Índice Pontual de Abundância do ponto 7 variou de 0.026 (1 contato) e 1.26 (49 contatos) resultando em 4.13 (161 contatos), e dominância de 0.112. No Ponto 7 foram observadas 7 aves como residentes locais. *Crotophaga ani* (anu-preto) e *Ammodramus humeralis* (tico-tico-do-campo) que habitam áreas abertas e o *Crypturellus tataupa* (inhambu-chintã) associado a capoeiras. *Sarcoramphus papa* (urubu-rei) é mais comumente encontrado em áreas de florestas extensas. *Tringa solitaria* (maçarico-solitário) e *Calidris alba* (maçarico-branco) são aves migratórias que habitam rios e lagos. *Ramphocaenus melanurus* (chirito) vive em florestas úmidas e capoeiras, empoleirando-se em cipó.

No ponto 10 o Índice Pontual de Abundância variou de 0.037 (1 contato) a 0.333 (9 contatos), resultando em 3.407 (92 contatos). O índice de diversidade de P10 foi 3.238 e a dominância baixa de 0.042. No Ponto 10 não foram verificadas aves residentes, somente prováveis residentes e ocasionais. A espécie *Leptotila verreauxi* (juriti-pupu) apresentou-se de forma relevante no ponto 10 e vive em locais bem arborizados e bordas de mata.

O último agrupamento detectado foi entre os pontos 8 e 9. No ponto 8 o Índice Pontual de Abundância variou de 0.030 (1 contato) a 0.333 (11 contatos), resultando em 3.121 (103 contatos). O índice de diversidade de P8 é igual a 3.366 e a dominância baixa de 0.042. No Ponto 8 foram levantadas 5 aves como residentes locais. *Patagioenas plumbea* (pomba-amargosa) vive em florestas úmidas, bordas de mata e capoeiras. *Conirostrum bicolor* (figuinha-de-rabo-castanho), *Dysithamnus mentalis* (choquinha-lisa) e *Mionectes rufiventris* (abre-asa-de-cabeça-cinza) ocorrem em borda de mata e capoeiras, sendo esta última considerada praticamente endêmica. *Psarocolius decamanus* (japu) é visível nas copas das árvores, onde faz seu ninho grande e característico, pendurado em formato de bolsa.

No ponto 9 o Índice Pontual de Abundância variou de 0.042 (1 contato) a 0.292 (7 contatos), resultando em 2.875 (69 contatos). O índice de diversidade calculado em P9 foi 3.113 e a dominância baixa 0.049. No ponto 9 foram encontradas 2 espécies residentes, entre elas *Accipiter*

striatus (tauató-miúdo) que é uma ave de rapina florestal, e *Odontophorus capueira* (uru), o qual é encontrada em matas com bom estado de conservação.

O hábito alimentar predominante nos pontos foi representado pelos onívoros e insetívoros. O hábito onívoro de aves para alguns biomas revela uma interface relacionada ao estado de preservação, pois sabe-se que o ambiente é capaz de fornecer uma maior diversidade de itens alimentares. Aves insetívoras, quando presentes em maior quantidade, pode estar diretamente relacionado à presença de plantações de cultivo, com maior quantidade de gramíneas e herbáceas, em torno da área de conservação, que facilitam a procriação de insetos, aumentando sua quantidade e conseqüentemente o alimento dessas aves (Padovezi et al. 2014). Algumas discussões de ornitólogos induzem ao entendimento de que a predominância, por exemplo, de espécies insetívoras num dado local, podem ser indicativos de efeito de fragmentação, e aumento de áreas agrícolas ou em processo de desmatamento (Andrade e Piratelli 2001).

De acordo com Nascimento et al. (2007), a mata ciliar rica em vegetação nativa é extremamente importante na conservação da avifauna. Percebe-se que nesses ambientes as aves dependem da vegetação para obtenção alimento, e em troca fornecem a dispersão de sementes. Na EEMPPO observou-se que grande parte das aves depende da alimentação onívora, incluindo frutos e sementes em sua dieta, além dos exclusivamente granívoros e frugívoros. No estudo de Ciambelli (2008), observou-se que as espécies de aves encontradas na Floresta Estadual de Botucatu participam da dispersão de sementes e conseqüentemente, da recuperação da vegetação local. As aves que ingerem predominantemente um tipo de alimento, utilizam outros para complementar sua dieta, e esse comportamento alimentar tem grandes implicações na reestruturação rápida da vegetação em áreas degradadas. As aves insetívoras, por exemplo, suplementam sua dieta com frutos e assim também desempenham papel de dispersoras de sementes. O padrão de espécies de aves encontrado em um determinado local ocorre de acordo com a disponibilidade de recursos daquele ambiente. As aves ocupam os ambientes de maneira dinâmica, movendo-se conforme a necessidade alimentar. A ausência de determinado grupo pode indicar a falta de recursos de um ambiente, ou então que outra espécie esteja utilizando o mesmo recurso (Yabe e Marques 2001).

O estado do Paraná ainda tem uma enorme carência de dados a respeito da composição, adaptação e comportamento da avifauna em fragmentos florestais em diferentes condições de integridade biótica. Inventários a longo prazo são essenciais para levantar espécies endêmicas e invasoras, determinando quais serão os caminhos para elaborar um bom plano de manejo, que garanta a capacidade de suporte para a avifauna e conseqüente restabelecimento das espécies nativas (Cavarzere et al. 2009). As figuras 7, 8, 9 e 10 trazem registros fotográficos na EEMPPO de parte da avifauna presente na unidade.



Figura 7. Registros fotográficos autorais de aves na EEMPPO. a) *Ardea cocoi* (garça-moura) b) *Ammodramus humeralis* (tico-tico-do-campo).

Fonte: Garcia (2022).



Figura 8. Registros fotográficos autorais de aves na EEMPPO. c) *Caracara plancus* (carcará) d) *Sittasomus griseicapillus* (arapaçu-verde) e) *Tachycineta albiventer* (andorinha-do-rio) f) *Stelgidopteryx ruficollis* (andorinha serradora) g) *Nannopterum brasilianum* (biguá) h) *Ardea alba* (garça-branca-grande) e *Egretta thula* (garça-branca-pequena) i) *Turdus amaurochalinus* (sabiá-poca) j) *Leptotila verreauxi* (juriti-pupu).
Fonte: Garcia (2022).



Figura 9. k) *Chloroceryle americana* (martim-pescador-pequeno) l) *Chloroceryle amazona* (martim-pescador-verde) m) *Megaceryle torquata* (martim-pescador-grande) n) *Mesembrinibis cayennensis* (coró-coró) o) *Tyrannus melancholicus* (suiriri) p) *Leucochloris albicollis* (beija-flor-de-papo-branco) q) *Zonotrichia capensis* (tico-tico) r) *Butorides striata* (socozinho)
 Fonte: Garcia (2022).



Figura 10. s) *Psittacara leucophthalmus* (periquitão) t) *Pitangus sulphuratus* (bem-te-vi) u) *Elaenia mesoleuca* (tuque) v) *Crotophaga ani* (anu-preto) w) *Turdus rufiventris* (sabiá-laranjeira) x) *Mionectes rufiventris* (abre-asa-de-cabeça-cinza) y) *Myiothlypis leucoblephara* (pula-pula-assobiador) z) *Basileuterus culicivorus* (pula-pula).

Fonte: Garcia (2022).

CONCLUSÃO

Determinar a riqueza de espécies e os fatores implícitos nas relações que criam a estabilidade para a manutenção de diferentes famílias de aves em florestas fragmentadas são fatores importantes para a ordenação de práticas de conservação e preservação. Assim, quando há o estabelecimento inicial das unidades de proteção integral, um dos primeiros focos de estudos ecológicos deve ser a avifauna, considerando a quantidade de serviços ecológicos prestados para a manutenção da floresta, bem como seu processo de recuperação. Os resultados de pesquisa aqui apresentados vêm reforçando a tese de que os fragmentos e corredores florestais podem ser uma das únicas estratégias para salvar do processo de extinção diversas espécies de animais, cuja significância ainda é uma incógnita. Nesse âmbito, foi observado no local uma grande diversidade de aves que atuam no equilíbrio da biota dispersando sementes, otimizando a polinização e estabilizando a cadeia trófica.

Considerando que as aves têm uma relação estrita com a configuração de seu habitat, o reconhecimento das espécies e suas relações ecológicas podem colaborar para o desenvolvimento de estratégias de conservação. Além disso, a série de dados, que foram obtidos, podem auxiliar no processo de tomada de decisões a respeito do manejo da fauna e flora. Cabe aos governos e setores públicos estimular estudos dessa natureza, para ampliar a possibilidade de incrementar as práticas de manejo desses ecossistemas tão importantes, além de continuar criando áreas de proteção.

O fato da estação ecológica estar numa condição de recuperação, provavelmente tem influência direta no recrutamento de espécies nas diferentes guildas tróficas, especialmente as onívoras. Dessa forma, possivelmente a continuidade de estudos na área demonstrará a médio e longo prazo o aumento destas, que tem maior habilidade em aproveitamento de recursos alimentares.

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ANEXO 1

Este trabalho segue as normas da Revista Zoologia (Curitiba)

Author Guidelines

Main Text

Title: The title should be written in sentence case (only scientific names, geographic locations, or other proper nouns should be capitalized, i.e. *Elater ferrugineus* L., Germany, etc.), and should include an accurate, clear and concise description of the reported work, avoiding abbreviations.

Authors and Affiliations: Provide the complete names of all authors, and their addresses for correspondence, including e.g., institutional affiliation (e.g. university, institute), location (street, boulevard), city, state/province (if applicable), and country. One of the authors should be designated as the corresponding author. It is the corresponding author's responsibility to ensure that the author list, and the individual contributions to the study are accurate and complete. If the article has been submitted on behalf of a consortium, all consortium members and their affiliations should be listed after the Acknowledgements section.

Abstract and Key Words: Please have your abstract and key words ready for input into the submission module. Key words should be in alphabetical order and ideally differ from the words used in the title. The abstract should include the following sections: introduction (stating the problem and the purpose of the study), very concise methods, results, and conclusion. The abstract should be informative (without general words), original, factful (provide a summary of the content of the article and key results of the study), written in good English, concise (between 200 and 250 words). It should be followed by up to 6–8 key words that convey the main meaning of the article.

Body Text: All papers should be in grammatically correct English. Non-native English speaking authors are required to have their manuscripts checked by a native English speaker or professional English-language editor prior to submission. Use either British/Commonwealth or American English provided that the language is consistent within the paper. A manuscript must be written with precision, clarity, and economy. The voice - active or passive - and the tense used should be consistent throughout the manuscript. Avoid the use of parenthetical comments and italics or bold for emphasis. This journal discourages the use of quotation marks except for direct quotations, words defined by the author, and words used in unusual contexts. Short quotations should be embedded in the text and enclosed in double quotation marks (""). Long quotations should be on a separate line, italicized, but without quotation marks. Single quotation marks are to be used only for a quotation that occurs within another quotation.

Spacing, Fonts, and Page Numbering: Single-space all material (text, quotations, figure legends, tables, references, etc.). Separate paragraphs with a blank line. Use a 12-point font (preferably Times New Roman or Arial).

Capitals: First capital letters should be used only in the beginning of a sentence, in proper names and in headings and subheadings, as well as to indicate tables, graphs and figure/s within the text. Software programmes should be written with capital letters (e.g., ANOVA, MANOVA, PAUP).

Italicization/Underlining: Scientific names of species and genera, long direct quotations and symbols for variables and constants (except for Greek letters), such as *p*, *F*, *U*, *T*, *N*, *r*, but not for *SD* (standard deviation), *SE* (standard error), *DF* (degrees of freedom) and *NS* (non significant) should be italicized. These symbols in illustrations and equations should be in italics to match the text. Italics should not be used for emphasis, and not in abbreviations such as e.g., i.e., et al., etc., cf. Underlining of any text is not acceptable.

Abbreviations: Abbreviations should be followed by '.' (full stop or period; for instance: i.e., e.g., cf., etc.). Note that you shouldn't add a full stop at the end of abbreviated words if the last letter of the abbreviation is the same as the last letter of the full word. For example, you should abbreviate "Eds", "Dr", "Mr" without full stop at the end. All measures, for instance mm, cm, m, s, L, should be written without full stop.

On the use of dashes: (1) Hyphens are used to link words such as personal names, some prefixes and compound adjectives (the last of which vary depending on the style manual in

use) (2) En-dash or en-rule (the length of an 'n') is used to link spans. In the context of our journal en-dash should be used to link numerals, sizes, dates and page numbers (e.g., 1977–1981; figs 5–7; pp. 237–258); geographic or name associations (Murray–Darling River; a Federal–State agreement); and character states combinations such as long–pubescent or red–purple. (3) Em-dash or em-rule (the length of an 'm') should be used rarely, only for introducing a subordinate clause in the text that is often used much as we use parentheses. In contrast to parentheses an em-dash can be used alone. En-dashes and em-dashes should not be spaced.

Footnotes: Avoid footnotes in the body text of the manuscript. It is always possible to incorporate the footnote into the main text by rewording the sentences, which greatly facilitates reading. Additionally, footnotes are not always handled well by software, and their usage may cause failures in the text processing.

Geographical coordinates: It is strongly recommended to list geographical coordinates as taken from GPS or online gazetteer, or georeferencer. Geographical coordinates must be listed in one of the following formats:

Definition: The locality consists of a point represented by coordinate information in the form of latitude and longitude. Information may be in the form of

Degrees, Minutes and Seconds (DMS),
 Degrees and Decimal Minutes (DDM), or
 Decimal Degrees (DD).

Records should also contain a hemisphere (E or W and N or S) or, with Decimal Degrees, minus (–) signs to indicate western and/or southern hemispheres.

Examples:

Example 1: 36°31'21"N; 114°09'50"W (DMS)

Example 2: 36°31.46'N; 114°09.84'W (DDM)

Example 3: 36.5243°S; 114.1641°W (DD)

Example 4: –36.5243; –114.1641 (DD using minus signs to indicate southern and western hemispheres)

Note on accuracy: Because GPS units are very commonly used today to record latitude/longitude, many authors simply give the GPS readings for their localities. However, these readings are much too accurate. For example, a GPS unit might give the latitude in decimal seconds as 28°16'55.87"N. Since one second of latitude is about 30 m on the ground, the second figure after the decimal in 55.87 represents 30 cm, yet a typical handheld GPS unit is only accurate at best to a few metres.

We therefore recommend two ways to report GPS-based locations. If you give the GPS reading without rounding off, make sure you include an uncertainty figure as a context for the over-accurate GPS reading. We recommend the Darwin Core definition of uncertainty (<http://rs.tdwg.org/dwc/terms/index.htm#coordinateUncertaintyInMeters>):

"The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location."

If you only give the GPS reading, please round it off to an implied precision appropriate to the error in the measurement, or to the extent of the area sampled. We suggest rounding off

to the nearest second in degree-minute-second format (28°16'56"N), which implies roughly ± 25-30 m at middle latitudes;

to four decimal places in decimal degree format (28.2822°N), which implies roughly ± 10-15 m at middle latitudes;

to two decimal places in decimal minute format (28°16.93'N), which implies roughly 15-20 m at middle latitudes.

Altitude: Many GPS users simply record the elevation given by their GPS unit. However, GPS elevation is NOT the same as elevation above sea level. GPS units record the elevation above a mathematical model of the earth's surface. The difference between this elevation and elevation above sea level can be tens of metres. In any case, the accuracy of a GPS elevation is often the same as the usual accuracy in horizontal position, so a GPS elevation such as '753 m' is much too accurate and should be rounded off to 'ca 750 m'.

We strongly recommend the use of Example 2 (the DDM format). The other three are also possible but will be recalculated to DDM during the process of online mapping from the HTML version of the paper.

The only restriction on format is in creating a KML (Keyhole Markup Language) file. KML latitudes and longitudes must be in the DD format shown above in Example 4.

Please also consider submitting a table of localities with your manuscript, either as a spreadsheet or in CSV text format. By doing so you will make your specimen localities much more easily available for use in biodiversity databases and geospatial investigations. The geospatial table will be put online as supplementary material for your paper. A minimum table will have three fields: species (or subspecies) name, latitude and longitude. A full table will have the same data for each specimen lot as appears in the text of your paper. Please check latitude/longitude carefully for each entry.

Units: Use the International System of Units (SI) for measurements. Consult Standard Practice for Use of the International System of Units (ASTM Standard E-380-93) for guidance on unit conversions, style, and usage.

Statistics: Use leading zeroes with all numbers, including probability values (e.g., $P < 0.001$). For every significant F-statistic reported, provide two df values (numerator and denominator). Whenever possible, indicate the year and version of the statistical software used.

Web (HTML) links: Authors are encouraged to include links to other Internet resources in their article. This is especially encouraged in the reference section. When inserting a reference to a web-page, please include the http:// portion of the web address.

Supplementary files: Larger datasets can be uploaded separately as Supplementary Files. Tabular data provided as supplementary files can be uploaded as an Excel spreadsheet (.xls), as an OpenOffice spreadsheets (.ods) or comma separated values file (.csv). As with all uploaded files, please use the standard file extensions.

Headings and subheadings: Main headings: The body text should be subdivided into different sections with appropriate headings. Where possible, the following standard headings should be used: Introduction, Methods, Results, Discussion, Conclusions, Acknowledgements, References. These headings need to be in bold font on a separate line and start with a first capital letter. Please do not number headings or subheadings.

Introduction – The motivation or purpose of your research should appear in the Introduction, where you state the questions you sought to answer, and then provide some of the historical basis for those questions.

Methods – Provide sufficient information to allow someone to repeat your work. A clear description of your experimental design, sampling procedures, and statistical procedures is especially important in papers describing field studies, simulations, or experiments. If you list a product (e.g., animal food, analytical device), supply the name and location of the manufacturer. Give the model number for equipment used. Supply complete citations, including author (or editor), title, year, publisher, and version number, for computer software mentioned in your article.

Results – Results should be stated concisely and without interpretation.

Discussion – Focus on the rigorously supported aspects of your study. Carefully differentiate the results of your study from data obtained from other sources. Interpret your results, relate them to the results of previous research, and discuss the implications of your results or interpretations. Point out results that do not support speculations or the findings of previous research, or that are counter-intuitive. You may choose to include a Speculation subsection in which you pursue new ideas suggested by your research, compare and contrast your research with findings from other systems or other disciplines, pose new questions that are suggested by the results of your study, and suggest ways of answering these new questions.

Conclusion – This should state clearly the main conclusions of the research and give a clear explanation of their importance and relevance. Summary illustrations may be included.

References – The list of References should be included after the final section of the main article body. A blank line should be inserted between single-spaced entries in the list. Authors are requested to include DOIs and/or links to online sources of articles, whenever possible! Where possible, the standard headings should be used in the order given above. Additional headings and modifications are permissible.

Subordinate headings: Subordinate headings (e.g. Field study and Simulation model or Counts, Measurements and Molecular analysis), should be left-justified, italicized, and in a regular sentence case. All subordinate headings should be on a separate line.

English Language Editing

This journal has well-defined policies for English language editing.

Authors are required to have their manuscripts edited by a native English speaker or professional English language editor BEFORE submission. Authors have to confirm by checking a tick box in the submission process that they have followed the above requirement:

"The text is checked by a native English speaker, or professional English language editor, duly acknowledged in the manuscript. I am aware that non-edited manuscripts could be rejected prior to peer-review".

The submission process includes an option to request a professional linguistic and copy editing at a price of EURO 15 per 1800 characters:

The authors are NOT obliged to use Journal's linguistic services, but they must ensure that their manuscripts have passed a proper linguistic editing before submission.

Citations and References

Citations within the text: Before submitting the manuscript, please check each citation in the text against the References and vice-versa to ensure that they match exactly. Citations in the text should be formatted as follows:

One author: Smith (1990) or (Smith 1990)

Note: The citations format depends on the way it is incorporated within the article's text:

Example:

1. According to Smith (1990), these findings...
2. These findings have been first reported in the beginning of the nineties (Smith 1990).

Two authors: Brock and Gunderson (2001) or (Brock and Gunderson 2001) Note: When choosing between formats refer back to examples above. Three or more authors: Smith et al. (1998) or (Smith et al. 1998)

Note: When choosing between formats refer back to examples above.

When citing more than one source, in-text citations should be ordered by the year of publication, starting with the earliest one:

(Smith et al. 1998, 2000, 2016; Brock and Gunderson 2001; Felt 2006).

Note: When you have a few citations from the same author but from different years (such as the case with Smith et al. above), the first year is taken into consideration when ordering the sources (in this case 1998, which is why Smith et al. come first in the list).

When having two or more fully identical citations (this can happen when you have more than one reference with exactly the same authors and years for one or two authors, or the same first author and year for author teams of three or more), the references are distinguished by adding the letters 'a', 'b', 'c', etc. after the years and this marking is followed in the in-text citations, respectively:

(Reyes-Velasco et al. 2018a, 2018b)

Authorship references for species should include a "," between author and year:

Brianmyia stuckenbergi Woodley, 2012.

References: It is important to format the references properly, because all references will be linked electronically as completely as possible to the papers cited. It is desirable to add a DOI (digital object identifier) number for either the full-text or title and abstract of the article as an addition to traditional volume and page numbers. If a DOI is lacking, it is recommended to add a link to any online source of an article.

List all authors cited in the References. For multi-authored papers, give all author names in full; the abbreviation "et al." is only allowed in the text. All journal titles should be spelled out completely and should not be italicized. Ensure that the References are complete and arranged according to name and year of publication. Personal communications and submitted manuscripts should be listed as unpublished results in the text and not listed in the References section.

Please use the following style for the reference list (or download the Pensoft EndNote style): [here](#). It is also available in Zotero, when searched by journal name.

Published Papers:

Polaszek A, Alonso-Zarazaga M, Bouchet P, Brothers DJ, Evenhuis NL, Krell FT, Lyal CHC, Minelli A, Pyle RL, Robinson N, Thompson FC, van Tol J (2005) ZooBank: The open-access register for zoological taxonomy: Technical Discussion Paper. *Bulletin of Zoological Nomenclature* 62: 210–220.

Accepted Papers:

Same as above, but "in press" appears instead the year in parentheses.

Electronic Journal Articles:

Mallet J, Willmott K (2002) Taxonomy: Renaissance or Tower of Babel? *Trends in Ecology and Evolution* 18(2): 57–59. [https://doi.org/10.1016/S0169-5347\(02\)00061-7](https://doi.org/10.1016/S0169-5347(02)00061-7)

Paper within conference proceedings:

Orr AG (2006) Odonata in Bornean tropical rain forest formations: Diversity, endemism and applications for conservation management. In: Cordero Rivera A (Ed.) *Forest and Dragonflies*. Fourth WDA International Symposium of Odonatology, Pontevedra (Spain), July 2005. Pensoft Publishers, Sofia-Moscow, 51–78.

Book chapters:

Mayr E (2000) The biological species concept. In: Wheeler QD, Meier R (Eds) *Species Concepts and Phylogenetic Theory: A Debate*. Columbia University Press, New York, 17–29.

Books:

Goix N, Klimaszewski J (2007) Catalogue of Aleocharine Rove Beetles of Canada and Alaska. Pensoft Publishers, Sofia-Moscow, 166 pp.

Book with institutional author:

International Commission on Zoological Nomenclature (1999) International code of zoological nomenclature. Fourth Edition. The International Trust for Zoological Nomenclature, London.

PhD thesis:

Dalebout ML (2002) Species identity, genetic diversity and molecular systematic relationships among the Ziphiidae (beaked whales). PhD Thesis, University of Auckland, Auckland, New Zealand.

Link/URL:

BBC News: Island leopard deemed new species <http://news.bbc.co.uk/>

Citations of Public Resource Databases: It is highly recommended all appropriate datasets, images, and information to be deposited in public resources. Please provide the relevant accession numbers (and version numbers, if appropriate). Accession numbers should be provided in parentheses after the entity on first use. Examples of such databases include, but are not limited to:

ZooBank (www.zoobank.org)

Morphbank (www.morphbank.net)

Genbank (www.ncbi.nlm.nih.gov/Genbank)

BOLD (www.barcodinglife.org)

Providing accession numbers to data records stored in global data aggregators allows us to link your article to established databases, thus integrating it with a broader collection of scientific information. Please hyperlink all accession numbers through the text or list them directly after the References in the online submission manuscript.

All journal titles should be spelled out completely and should NOT be italicized.

Provide the publisher's name and location when you cite symposia or conference proceedings; distinguish between the conference date and the publication date if both are given. Do not list abstracts or unpublished material in the References. They should be quoted in the text as personal observations, personal communications, or unpublished data, specifying the exact source, with date if possible. When possible, include URLs for articles available online through library subscription or individual journal subscription, or through large international archives, indexes and aggregators, e.g., PubMedCentral, Scopus, CAB Abstracts, etc. URLs for pdf articles that are posted on personal websites only should be avoided.

Authors are encouraged to cite in the References list the publications of the original descriptions of the taxa treated in their manuscript.

Ordering references: All references should be ordered alphabetically by author name (but see below).

If the references have the same first author and a varying number of co-authors, the ordering should be based on the number of co-authors starting with the lowest; all articles with the same first author and two or more co-authors (thus cited as et al. in the text) should be listed chronologically, as follows:

Smith J (2018) Article Title. Journal Name 1: 1–10. <https://doi.org/10.3897>

Smith J, Gunderson A (2017) Article Title. Journal Name 1: 10–20. <https://doi.org/10.3897>

Smith J, Gunderson A, Brock B (2011) Article Title. Journal Name 1: 20–30. <https://doi.org/10.3897>

Smith J, Brock B, Gutierrez R, Gunderson A (2013) Article Title. Journal Name 1: 15–30. <https://doi.org/10.3897>

Smith J, Brock B, Gunderson A (2015) Article Title. Journal Name 1: 10–30. <https://doi.org/10.3897>

If both the first author and year of publication match within the categories above, the references are distinguished by adding the letters 'a', 'b', 'c', etc. after the year of publication and this marking is followed in the in-text citations, respectively.

Illustrations, Figures and Tables

Figures and illustrations are accepted in the following image file formats:

EPS (preferred format for diagrams)

TIFF (at least 300dpi resolution, with LZW compression)

PNG (preferred format for photos or images)

JPEG (preferred format for photos or images)

GIF

BMP

SVG

Vector files in any of the following formats EPS, SVG or PDF are requested for phylogenetic trees and cladograms.

The journal is printed in B5 paper size with the maximum printing area of 128 mm × 199 mm. Whenever possible, individual figures should be prepared as composite figures.

Should you have any problems in providing the figures in one of the above formats, or in reducing the file below 20 MB, please contact the Editorial Office at journals@pensoft.net

Figure legends: All figures should be referenced consecutively in the manuscript; legends should be listed consecutively immediately after the References. For each figure, the following information should be provided: Figure number (in sequence, using Arabic numerals – i.e. Figure 1, 2, 3 etc.); short title of figure (maximum 15 words); detailed legend, up to 300 words. Illustrations of measurable morphological traits should bear mute scale bars, whose real size is to be given in the figure captions.

Please note that it is the responsibility of the author(s) to obtain permission from the copyright holder to reproduce figures or tables that have previously been published elsewhere.

Figure citations in the text should always be with Capital "F" and En-dash for ranges. One figure with a full stop, figures without.

Example: Fig. 1, Figs 1–3, Fig. 2A–E.

Citations of figures from other publications should always be Lower Case (fig. / figs). When two subsequent figures or parts are cited (for instance figures 1 and 2 or A and B), a comma should be used.

Example: Figs 1, 2 and Fig. 1A, B.

Parts belong to one figure.

Example: Fig. 1A, B and Fig. 2A–E.

On the use of Google Maps

All uses of Google Maps and Google Earth Content must provide attribution to Google, according to [Google Maps/Earth Additional Terms of Service](#) (see also [Permission Guidelines for Google Maps and Google Earth](#)). The attribution should be visible on each map in the form, for example: "Map data 2019 (C) Google".

Tables: Each table should be numbered in sequence using Arabic numerals (i.e. Table 1, 2, 3 etc.). Tables should also have a title that summarizes the whole table, maximum 15 words. Detailed legends may then follow, but should be concise.

Small tables can be embedded within the text, in portrait format (note that tables on a landscape page must be reformatted onto a portrait page or submitted as additional files). These will be typeset and displayed in the final published form of the article. Such tables should be formatted using the 'Table object' in a word processing program to ensure that columns of data are kept aligned when the file is sent electronically for review. Do not use tabs to format tables or separate text. All columns and rows should be visible, please make sure that borders of each cell display as black lines. Colour and shading should not be used; neither should commas be used to indicate decimal values. Please use a full stop to denote decimal values (i.e., 0.007 cm, 0.7 mm). Larger datasets can be uploaded separately as Supplementary Files. Tabular data provided as supplementary files can be uploaded as an Excel spreadsheet (.xls), as an OpenOffice spreadsheets (.ods) or comma-separated values file (.csv). As with all uploaded files, please use the standard file extensions.

Linked Data Table for Primary Biodiversity Data

Definition: A linked, or semantically enhanced, data table for primary biodiversity data is a table where data about specimens, taxa, sequences, images, sound recordings, traits, habitat preferences and biotic interactions between specimens or taxa are presented, whenever possible, through hyperlinked persistent unique identifiers, following community-agreed standards and ontologies. The use of hyperlinked identifiers allows for linking to external data resources and also within and between table rows, not only by humans, but also by machines.

This journal strongly encourages authors to present their data in a linked data table, using the template below. The template structure is NOT fixed and can be changed to reflect the specifics and composition of data used in a particular study, following some simple but important rules. The table does not replace or exclude the detailed listing of specimen data (occurrences, label data) in the Materials examined sections of the taxon treatments.

The template does not differ much from what the authors normally use (for example, specimens-BY-sequences-BY-taxa or similar); however, (1) it follows some standardisation in format and structure, (2) it is semantically enriched with links to community-accepted ontologies and external sources of information, (3) information from it can be extracted and distributed to various data aggregators, thus (4) increasing the re-use, discoverability, visibility and citation probability of

your research and data (for more details see the blog [How to get data from research articles back into the research cycle at no additional costs](#)).

When filling in the table or changing its structure, please consider the following guidelines:

The template is read-only. To start working with it, please open and copy it to an editable file in Google Spreadsheet (through the Make a copy option from the File menu) or download it in Excel, CSV, TSV or other format.

Keep the table as simple and as concise as possible. It is a table of identifiers linked to the actual (meta)data rather than a representation of your complete data.

The table caption should always start with: "Linked data table of ...".

Delete all empty columns for which you do not provide data. The table can be reduced to a few columns, depending on the purposes of the study.

- Example-1: If you publish a revision or phylogenetic study of a taxon, it would be sufficient to reduce the table to the first core or source (left) group of data on taxa/specimens, while the entire second target (right) group could be deleted starting with the column of biotic interactions.
- Example-2: If you publish an analysis of the biotic interactions between two groups of taxa, you could reduce the table to: (1) List of source species, (2) Type of interaction, (3) List of target species and (4) Source of information (citation or unpublished source).

You can add additional columns for data types that are missing in the table. Please do not add columns for data which are already available within the actual data record to which the hyperlinked identifier points to.

Example: there is no need to add columns for details on localities (e.g. province, district, verbatim descriptions), sampling events, collector names etc., because the link to the Specimen code in GBIF, iDigBio or DiSSCo contains these data in both human- and machine-readable format.

Changing of the uppermost table headings (rows 1-3) is NOT desirable, because they are linked to ontologies/vocabularies to provide the semantic meaning of data in the respective columns.

- Example-1: if you need to add one more column to list accession numbers of another gene, just copy the previous identical column and paste it to the right, then change the gene name in the heading.
- Example-2: if you need to add a column for a data type which is absent in the template, please name and link it to a term from a community-agreed vocabulary (e.g. Darwin Core, UBERON) or ask us for advice using the email address below.

Relatively small data tables (e.g. of up to 300-400 records) should be included as an Appendix to the article text and also as a supplementary data file; larger datasets can be deposited at external open thematic repositories and/or supplementary files to the article. In cases where datasets are deposited in an external open repository or as supplementary files to the article, they should be described with a link to the openly available dataset in a Data resources section of the article.

Most of the hyperlinks to the different data elements in the table will be provided in-house by Pensoft (see the last "Linked by" row in the template). Authors are required to hyperlink only a few data columns for which the linking cannot be provided by the publisher.

- Example: There is no easy way for the publisher to discover and especially to reconcile and link the actual specimen the authors have studied, hence the authors are required to provide these hyperlinks in the table (see "Linked to" row in the template) upon submission of the manuscript.

Use consistent data formatting when filling in columns, such as Latitude and Longitude, for example (see the journal's Author guidelines for more details).

Do not leave fields empty in cases where you have repeatable data for these:

- Example-1: if several specimens of a taxon are listed in the table, please fill in the taxon name in each row (do not list a taxon name only once at its first mention only)
- Example-2: There are still many collections in which specimen data are not indexed in GBIF, iDigBio or DiSSCo (or elsewhere). Please fill in the specimen codes, even when

these cannot be hyperlinked to a collection network.

Controlled vocabulary terms are listed in separate spreadsheets in the document containing the template. The authors are encouraged to select terms from the drop-down

menus whenever possible. The examples below explain how the author could add a term missing in a vocabulary or add a new vocabulary in a column, for example, for data types not present in the template, such as Life stage, Body part etc.

○ Example-1: In case you would like to fill in a data entity which is not featured in the drop-down menu, you can add an entity as free text in the associated vocabulary spreadsheet (e.g. 'envo-environments' for the column 'Habitat / Environment (after ENVO Ontology)'). This will add your entity to the drop-down menu and you will be able to select it. Please, do not alter any of the other entities in the sheets, as this would prevent us from correctly linking to the ontology terms. For more guidance, you can follow this brief tutorial: <https://youtu.be/o96tZZITs1w>.

Video caption: How to add free text to a cell which has a drop-down menu:

1. Find the spreadsheet sheet which contains the ontology terms which are listed in the dropdown menu (e.g. 'envo-environments' for the column 'Habitat / Environment (after ENVO Ontology)') and add your entity as free text at the end of the list in the 'label' column. Leave the IRI column empty. You can write a definition of your entity in the 'definition' column.
2. Go back to the 'template' sheet and scroll through the dropdown menu until you find the entity you added. You can now select it.

Example-2: You can also use the vocabularies which are present in the current document (e.g. uberon-life-stages) or introduce a new vocabulary in a separate spreadsheet and then

visualise it as a new data column (please see the tutorial below). <https://youtu.be/Byyvzhzn7vNw> Video caption: How to add a new column containing a dropdown with ontology terms:

1. Insert a new column inside the 'template' sheet and name it.
2. Go to <https://bioportal.bioontology.org/> (or any other ontology repository) to find an ontology that you want to use. BioPortal offers an ontology browser which allows you to search for ontology terms. A similar ontology browser is offered by Ontobee (<http://www.ontobee.org/>).
3. Find an ontology class which describes the types of entities which you want to list in the drop-down menu (e.g. Image class for the different types of images). Copy its resource identifier (ID).
4. Go to <http://sparql.bioontology.org/>, BioPortal's SPARQL endpoint which allows you to perform semantic queries on ontologies featured in BioPortal. Paste in the following query by replacing 'ID' with the ID that you copied in the previous step:

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> SELECT ?class ?label
```

```
WHERE {
```

```
?class rdfs:subClassOf <ID>. ?class rdfs:label ?label.
```

```
} GROUP BY ?class
```

Do not forget the angle brackets surrounding the IRI (< >). Click 'run query' and copy the results.

5. Go back to the spreadsheet containing the template and create a new sheet (in Google Spreadsheets, you can do this from the + button in the bottom menu). Paste the SPARQL query results inside the new sheet. Use the 'Find and replace' option to remove any unnecessary characters (e.g. angle brackets (< >) and quotation marks ("")). Change the name of the sheet so that it contains the name of the ontology you used and the type of entities you listed.

6. Go back to the template sheet and click on the cell where you want the dropdown menu to be. Select 'Data' from the upper menu and then 'Data validation'. For Criteria, select 'List from range' and click the table icon to the right to select data range. Go back to the new sheet that you created in step 5 and select the range of values which you want to display in the drop-down menu (e.g. the labels of the different image types). Click 'Save' to create the drop-down menu. You can copy the menu along the column rows.

Link to the Google spreadsheet template:

https://docs.google.com/spreadsheets/d/1gv7RwKPq7LxGcy114qoEEusU4DLbva3it_7Dh6Nvvt8/edit?usp=sharing

Questions and feedback should be sent to: semanticpublishing@pensoft.net Taxonomic Treatments

Criteria for publication of new species descriptions

Stand-alone single species descriptions will be considered in well-studied taxa, fossils or if they represent monotypic (monophyletic) groups. Additional criteria for considering stand-alone single species descriptions will be that the species exhibits unusual characters that can change the concept of the higher taxon to which it belongs; the material is rich, providing information on the biogeography, phylogeny, biology or ecology of the species, and there is little chance that other material from this region can be brought together within the foreseeable future; the higher taxon to which it belongs has not been reported from the (larger) geographic area where it occurs; species collected in areas of high conservation importance (Galapagos, for example); the new species is economically or medically important, being proven to be a pest, invasive species, transmitter of diseases, or otherwise.

Stand-alone single species descriptions in poorly studied or hyperdiverse groups should be avoided, unless they are placed into the context of a review or revision, or the study provides rich data on their biology, ecology, hosts/parasite species, life cycle and immature stages descriptions and others.

The following guidelines are provided to ensure that other elements of the work follow modern standards and enable the full advantage of the ARPHA platform.

Types and taxonomically important specimens.

- Mandatory: Verbatim data (or photos) of the specimen label(s) put in quotes, including, if known, the collection date, name of the collector(s), (old) locality name(s), field

number(s), and date of deposition in the relevant museum should be included in the specimen records as well. Include latitude, longitude, elevation, habitat, microhabitat

information of primary type material. For format of geographical coordinates see section "Main text" above.

- Mandatory: The holotype should be deposited in a publicly accessible collection. For the other types or taxonomically important specimens the deposition in public collections

is strongly recommended.

- Strongly recommended: Permanent identifiers for all type specimens and related materials. Unique identifiers are for example museum collections specimen IDs. Unique

identifiers can be provided also by international taxon-based databases that do not indicate ownership, such as AntWeb.org for ants, for example.

- Strongly recommended: Specimen occurrence records should follow the DarwinCore standard. Data on all types and related materials should be described in accordance to

the [following instructions](#), and, additionally, in a [Linked table for primary biodiversity data](#). ○ Strongly recommended: Details on collection permits should be included.

Differential diagnosis.

- Mandatory: Differential diagnoses should be short, concise and meaningful. A diagnosis should be a means of confirming the identification after using the key, or allow a reader

to recognize the distinctive features of the taxon at hand. Diagnoses should describe the species and not the sample, or in other words, they should be sample-independent. A list of diagnostic character states, or a diagnostic combination of character states, along with a statement about how each character state differs from closely related, or closely similar, species.

- Mandatory: Include all relevant congeners and cite the reference taxonomy being followed, so that others can see which species have been considered.

- Strongly recommended: Consider presenting the differential diagnosis in a table, if long lists of differences and/or species are included.

- Strongly recommended: The sample size for each species should be given whenever possible, so the reader can evaluate the strength of the evidence for diagnosability.

Morphological description. To the extent accepted as a minimum standard in the respective taxon group, so that to provide the diagnostic evidence that the species is new. Rich illustrative material including images, drawings, and where possible microCT should be included.

Key. Mandatory in all cases of stand alone species description which are not put into the context of a revision; keys should help to identify the new species in relation to the closest congeners; in case of availability of a key to the species group, the new species should be placed within the key.

DNA-based descriptions. Given some controversies and criticism related to "DNA-only" or "DNA-based" descriptions, such descriptions could be considered only in special cases, e.g. in a necessity of streamlined descriptions of multiple new species in megadiverse, poorly studied taxa with strong record on the informativeness of DNA barcodes (deep divergences) and correlated external features shown on rich illustrative material.

- Mandatory: Rich illustrative material (photos, drawings) of the voucher (type) specimens and morphological details important for the identification of the taxon under study (microCT or others).
- Mandatory: The reason to use mostly DNA characters for diagnosing and descriptions of new species should be justified in the Materials and Methods section of the paper.
- Mandatory: Explain how the new species differentiates from the previous or related species described in the same paper.
- Mandatory: Etymology and differential diagnoses are mandatory in "DNA-based" species descriptions as well.
- Strongly recommended: Morphological descriptions are to be included in "DNA-based" descriptions as well, whenever possible. Exceptions from this rule should be justified in

the Material and Methods section of the paper.

- Strongly recommended: DNA sequences of relevant existing name-bearing types, so that it is clear to which clade(s) the existing name(s) belong. If such sequences are not available, it is mandatory to explain how previous names are applied in the manuscript.

DNA sequences.

- Mandatory: When new sequences are reported, their GenBank/EMBL/DDBJ accession number(s) should be included in the manuscript.
- Mandatory: In all taxa where using DNA sequences is accepted as a norm; strongly recommended in all other taxa.
- Strongly recommended: Use the GenSeq terms if DNA sequences of type material are reported in the manuscript (see section Sequence data below and also Chakrabarty P,

Warren M, Page L (2013) GenSeq: An updated nomenclature and ranking for genetic sequences from type and non-type sources. *ZooKeys* 346: 29-

41). <https://doi.org/10.3897/zookeys.346.5753>). See

- Strongly recommended: Whenever possible, DNA sequences should be made available to the editors and reviewers.

Etymology. Mandatory: Including Latin form for species-group epithets (adjective, noun in apposition, noun in genitive case, or "random sequence of letters" not needing accord with generic gender) and gender for genus-group names.

Data on biology, ecology, and biotic interactions.

- Mandatory: Where such data are available.
- Strongly recommended: Illustrative materials (habitat photos, videos of species' behavior, etc.).

Introduction, discussion and conclusions texts or sections. Mandatory. Sequence data

Manuscripts containing novel amino acid sequences (e.g. primer sequences) will only be accepted if they carry an International Nucleotide Sequence Databases (INSD) accession number from the European Biology Laboratory (EMBL), GenBank Data Libraries (GenBank) or DNA Data Bank of Japan (DDBJ). We strongly recommend that authors include institutional catalog numbers for specimens preserved in collections, and information identifying sequences that are derived from type specimens (see below) when they deposit data in genetic databanks. A summary table with the INSD accession [catalog] numbers should be included in either Materials and Methods or Data Resources section of the paper. If specimens were not vouchered (tissued specimens should be vouchered whenever possible!), collection locality data and possibly photographs of tissued specimens must be provided. A nomenclature for genetic sequences for types and confidently identified nontype specimens has been proposed by Chakrabarty et al. (2013); a sequence from a holotype is identified as genseq-1, one from a paratype is identified as genseq-2, one from a topotype is genseq-3, etc. The genetic marker(s) used should also be incorporated into the nomenclature (e.g. genseq-2 COI).

Examples

Table 1. Ranking Sequence Reliability. Ranking of source materials of genetic sequences based on reliability of taxonomic identification. Examples of the source material are listed in the third column with the last column providing the corresponding GenSeq nomenclature (after Chakrabarty et al. (2013)).

Reliability Source Materials Ranking

Highest Primary Types 1st

2nd Secondary Types

Topotypes (vouchered), or non-type

3rd specimens listed in original description or

redescription

4th Collections-vouchered non-types (not from original description or redescription)

5th Photo voucher only Lowest No voucher

Examples

Holotype, Lectotype, Syntype, Isosyntype, Neotype, Isotype

Paratype, Paralectotypes, etc.

Topotype, Non-type specimen listed in original description or redescription

Vouchered specimen

No specimen voucher but photo voucher available

Non-vouchered

Corresponding GenSeq Nomenclature

genseq-1 genseq-2

genseq-3

genseq-4

genseq-5

No classification

Table 2. Example Reporting Table. Examples of how links between genetic sequences and vouchers in institutional collections could be displayed as a table in publications reporting new sequences.

Species

Specimen Catalog #

LSUMZ 13636 (holotype)

AMNH 229558 (paratype)

UMMZ 236321 (topotype)

FMNH 96353 (non-type specimen voucher) NMNH 12345PV2 (photo voucher)

GenBank # COI [HM590594](#) [JZ590596](#) [BK590595](#) [AY722169](#) NA

GenSeq Nomenclature

genseq-1 COI, ND1 genseq-2 COI genseq-3 COI, ND1 genseq-4 COI, ND1 genseq-5 ND1

Typhleotris mararybe *Paretroplus tsimoly* *Nandopsis haitiensis* *Halieutichthys intermedius* *Equulites absconditus*

ND1

[HM590606](#)

NA

[BK590607](#) [AY722306](#) [BG34621](#)

International Code of Zoological Nomenclature

This journal will publish papers that strictly adhere to the rules of the last edition of the [International Code of Zoological Nomenclature](#) and its [amendment](#). Authors are also advised to follow all recommendations of the Code and to consult the guidelines below prior to submitting the manuscript.

General: Each first mentioning of an animal species name within the text must be provided with author(s)' name(s). Year of publication of an animal species should be given in taxonomic revisions with quotation of the work providing the original species' description in the list of references.

New names: When new taxonomic acts are proposed, they should be explicitly indicated as being new by adding the respective abbreviation after the taxon name i.e., sp. nov., comb. nov., nomen nov. Authors of newly described taxa should be given any time the taxon is mentioned, if different from the publication authors.

Examples:

Genus X-us Smith, new genus (author(s) of the publication and authority (-ies) of the taxon is/are identical);
X-us albus Jones & Peters, new species (the publication is authored by persons different in composition or combination from the authority (-ies) of the taxon itself, e.g. Smith, Jones & Peters or Peters & Jones).

We highly recommend that authors of new species are also included as co-authors of the work where the taxa are described. If the authors of the work do not want to include the authors of the taxonomic name then to be absolutely certain that the authority for the name is unequivocal there should be a statement in the work saying that these authors (of the name) are responsible for making the name available under the code (Article 50.1.2, etc.) i.e. they are responsible for coining the name and for satisfying all other criteria for availability.

New family-group names: Although all family group names are derived/based on their type genus, the type genus is to be compulsorily designated in any description of a family-group name published after 31st

December 1999 (Article 16.2). It is not sufficient that the type genus is mentioned as belonging to the new family-group name; it must be stated that this is the type genus. We recommend a single type line as:
Type-genus: *Musca* Linnaeus, 1758.

New genus-group names: The origin ("etymology", or "derivatio nominum") of name and its gender should be indicated. The type-species and the character of the proposed taxonomic act should be specified for new genus-group names. The type species name should be given in its original combination with an author and year. If the type species is now considered a junior synonym there need to be a clear mention of that. The fixation type should derive from the International Code of Zoological Nomenclature (see Articles 68 & 69; original designation, monotypy, absolute tautonymy, Linnaean tautonymy, subsequent monotypy, subsequent designation).

Example:

Sympycnus Loew

Type-species: *Porphyrops annulipes* Meigen, 1824 by subsequent designation of Coquillett (1910: 610) =*pulicarius* Fallen, 1823.

New species-group names: According to the ICZN Art. 11.9, but also Art. 11.3 the origin "etymology", or "derivatio nominum") new species-group names should be supplemented by information on whether the epithet is an 1) adjective or participle in the nominative singular; 2) noun in the nominative singular; 3) a noun in the genitive case; 4) an adjective used a substantive in the genitive case; or 5) an arbitrary combination of letters (ICZN Art. 11.3). For species-group names, there are two separate statements of type information that are needed:

the statement of species' type locality – that is the exact place whence the primary type origins, including exact collecting dataplace with geographical coordinates, geographical or political unit (Area/ District/ State) and country; also, if possible, supplementary locality information should be included – habitat type, method of collecting, date, collector's names, host name (for parasites), etc.

there should be a separate statement about the type specimen, exact quotation of its original label, condition of specimen (dry pinned, in alcohol, slide, fossil, etc.) and repository (organization's name and city).

Examples:

For a new species:

Type locality: USA, Virginia: Fairfax County, Kingstowne, 38°46'N, 77°07'W, broad-leaf forest, under bark, 10 July 2000, J. Smith leg.

Type specimen: Holotype male, pinned, with genitalia in a separate microvial. Original label: "USA, VA, Fairfax, Kingstowne, 38°46'N, 77°07'W, 12 Oct 2003, BJ & FC Thompson"

"USNM ENT 00033805" [Code 49 barcode], "HOLOTYPE / *Xylota* / x-us / Thompson [red handwritten label].

For a previously described species:

Lectotype male, pinned ... [details] here designated to fix the concept of *X-us albus* Jones and to ensure the universal and consistent interpretation of the same. Or ... [details then] by designation of Smith (1976: 999).

Previously published names: For a previously published name, please provide the year of description. Also use the parentheses convention for subsequent new combinations. [Etymology]

Authors of new species name should state exactly what the epithet is in terms of the ICZN, as outlined in Article 11.9.1.1 to 11.9.1.4 as well as 11.3. A name may be a word in or derived from Latin, Greek or any other language (even one with no alphabet), or be formed from such a word. In short, a name can be declared as arbitrary combination (the best solution) or must be or be treated as:

- I) a word of two or more letters, or a compound word, and, if a Latin or latinized word must be, or be treated as:
 1. an adjective or participle in the nominative singular (as in *Echinus esculentus*, *Felis marmorata*, *Seioptera vibrans*), or
 2. a noun in the nominative singular standing in apposition to the generic name (as in *Struthio camelus*, *Cercopithecus diana*), or
 3. a noun in the genitive case (e.g. *rosae*, *sturionis*, *thermopylarum*, *galliae*, *sanctipauli*, *sanctae-helenae*, *cuvieri*, *merianae*, *smithorum*), or
 4. an adjective used as a substantive in the genitive case and derived from the specific name of an organism with which the animal in question is associated (as in *Lernaecocera luscii*, a copepod parasitic on *Trisopterus luscus*).

II) An adjectival species-group name proposed in Latin text but written otherwise than in the nominative singular because of the requirements of Latin grammar is available provided that it meets the other requirements of availability, but it is to be corrected to the nominative singular if necessary.

Arranging sections within species treatments (sections in square brackets are requested for new descriptions only!):

[Name]

[Material]

- [Type material]

- Other material

[Diagnosis]

[Description]

[Etymology]

Distribution

Ecology (including phenology)

Conservation status (optional, we encourage authors to follow the IUCN categories and criteria, please see http://www.iucnredlist.org/static/categories_criteria_3_1#critical) Discussion (optional, but very desirable)

Materials and Methods

In line with responsible and reproducible research, as well as FAIR (Findability, Accessibility, Interoperability and Reusability) data principles, we highly recommend that authors describe in detail and deposit their science methods and laboratory protocols in the open access repository protocols.io.

Once deposited on protocols.io, protocols and methods will be issued a unique digital object identifier (DOI), which could be then used to link a manuscript to the relevant deposited protocol. By doing this, authors could allow for editors and peers to access the protocol when reviewing the submission to significantly expedite the process.

Furthermore, an author could open up his/her protocol to the public at the click of a button as soon as their article is published. Stepwise instructions:

1. Prepare a detailed protocol via protocols.io.
2. Click Get DOI to assign a persistent identifier to your protocol.
3. Add the DOI link to the Methods section of your manuscript prior to submitting it for peer review.
4. Click Publish to make your protocol openly accessible as soon as your article is published (optional).
5. Update your protocols anytime.

Supplementary Files

Online publishing allows an author to provide datasets, tables, video files, or other information as supplementary information, greatly increasing the impact of the submission. Uploading of such files is possible in Step 6 of the submission process.

The maximum file size for each Supplementary File is 20 MB.

The Supplementary Files will not be displayed in the printed version of the article but will exist as linkable supplementary downloadable files in the online version. While submitting a supplementary file the following information should be completed:

File format (including name and a URL of an appropriate viewer if format is unusual)

Title of data

Description of data

All supplementary files should be referenced explicitly by file name within the body of the article, e.g. "See supplementary file 1: Movie 1" for the original data used to perform this analysis. Ideally, the supplementary files should not be platform-specific, and should be viewable using free or widely available tools. Suitable file formats are:

For supplementary documentation:

PDF (Adobe Acrobat) For animations:

SWF (Shockwave Flash) For movies:

MOV (QuickTime)

MPG (MPEG) For datasets:

XLS (Excel spreadsheet)

CSV (Comma separated values)

ODS (OpenOffice spreadsheets)

As for images, file names should be given in the standard file extensions. This is especially important for Macintosh users, since the Mac OS does not enforce the use of standard file extensions.

Please also make sure that each additional file is a single table, figure or movie (please do not upload linked worksheets or PDF files larger than one sheet).

Voucher and type specimens

Specimens including types (where appropriate) or vouchers that have received authoritative identification are the foundations for all biological studies from taxonomy and systematics to ecology and biogeography and including all aspects of biodiversity survey and inventory. Representative individuals (or parts of entire specimens that retain diagnostic information for identification) used in any study reported in the Journal should be deposited in a recognized biological collection, so that such are freely available to the research community. Vouchers should also be deposited to substantiate records of sequence data in all molecular studies (e.g., phylogeography and diagnostics), and ideally the physical voucher should be the remaining portion(s) of individual specimens that have been processed for DNA extraction. It is recommended that such specimens not be limited to the holotype and a limited number of paratypes in descriptions, or relatively few specimens derived from survey or from ecological studies. It is a requirement of Zoologia that all manuscripts must document the collection(s) where the specimens (types or vouchers) are deposited along with their respective catalogue or accession numbers in those repositories.

Material Citations Formatting Guidelines

Authors are strongly encouraged to adhere to the new fine-grained formatting of the material examined (species occurrence records) as shown below. Please note that this new fine-grained formatting is NOT COMPULSORY and is introduced for testing for an undefined period, during which we hope to receive your feedback.

Nonetheless, it is recommended to follow the guidelines to ensure accurate conversion of your records to XML and consequent indexing in GBIF, Plazi, and other important resources. Indexing of each individual occurrence record in GBIF and linking back to your article will provide much higher visibility, data usability, dissemination, and citation probability of your

work! Adapted from: CETAF best practices in electronic publishing in taxonomy (<https://doi.org/10.5852/ejt.2018.475>).

Order

Each material citation is composed of diverse data fields (material, locality, date, etc.) that are tagged, using Darwin Core (DWC) terms. To efficiently perform this, it is important to ensure that the different fields of a material citation are consistently presented in the same order throughout the article or, at the very least, within a taxon treatment.

The preferred order is as follows:

For botanical and mycological data, please use "Collection number" instead of "collector [followed by "leg."]."

The collection number encompasses all gatherings from a single specimen (e.g., leaves, flowers, piece of wood) which may be preserved on different herbarium sheets and in different herbaria.

The preferred format for botanical/mycological data should be as follows:

COUNTRY • specimens [e.g. 1 ♂ (or M, or male), size]; geographic/locality data [from largest to smallest]; coordinates; altitude/elevation/depth [using alt./m a.s.l. etc.]; date [format: 16 Jan. 1998]; collector [followed by "leg."]; other collecting data [e.g. micro habitat/host/method of collecting]; barcodes/identifiers [e.g. GenBank: MG779236]; institution code and specimen code [e.g. CBF 06023].

GABON - Estuaire • J.J. Wieringa et al. 6543 (IEC, K, LBV, MO, P (P01234567), US, WAG (WAG0012345, WAG0012346, wood: WAG0012347, fl in spirit: WAG0012348)); 35 km NE of Libreville; 0°38.8'N, 9°58.9'E; alt. 30 m; 12 Feb. 2017; fl • E.L.A.N. Simons 1212 (P, LBV, WAG (WAG0987654), Z); Libreville, Sibang arboretum; 0°27.8'N 9°29.4'E; alt. 16 m; 15 Jul 2017; fr. - Ogooué-Maritime • J.J. Bos 10123 (P, WAG); around Port Gentil; 0.82°S, 8.80°E; alt. 5 m; 4 Apr 1986; fl, fr.

Punctuation

A bullet point (• [unicode: 2022]) is used to signify the beginning of a material citation. Within each citation, the different fields are delimited by a semicolon. A single field can be composed of several elements, which are separated by commas (e.g. the details region, area, town and street for the 'locality' field).

Semicolons should not be used elsewhere in a material citation.

Repetitive data

Authors can indicate repetitive data with indications such as "same data as for holotype", "same data as for preceding", "same locality", "ibid", etc. as long as the same method and wording are used consistently throughout the paper.

If a material citation is identical to another with only one or two differences, the exceptions should be listed after the mention of repeated data e.g.:

'Missing' elements

It is not necessary to include information such as "no date" or "no locality data"; just list the elements that are available.

Label citations

We recommend including photos of labels as figures if they contain data that cannot be standardised. Double quote marks (" ") must be used to represent label citations that do not correspond to (or cannot be reliably interpreted as) specific DWC terms. This data will simply be parsed as a verbatim citation.

Only quote marks should be used to present verbatim label data and they should not appear elsewhere in a material citation.

Author interpretation

Use square brackets [] to distinguish data that has been interpreted by the author e.g., coordinates interpreted from a locality, or translations of label data:

Data fields

The different data fields that are tagged in a material citation are explained below, along with the formatting needed to achieve maximum output and precision.

Any specimen data presented in a separate table cannot be linked back to the citation and tagged for conversion.

Country (country / waterBody)

The citations must be listed by either country or water body, using a separate paragraph for each new zone. Countries should be listed in alphabetical order. If another method is used (e.g. geographic groups) please state this in the Material and Methods section.

If the material is organised by region, please use the following format:

Material (organismQuantity / organismQuantityType / sex / typeStatus)

This field comprises several indications about the specimens cited: number, type (e.g. specimen, juv., shell, excuviae), sex and type status. All subsequent elements of a citation will be applied to the specimens presented in this field.

Locality (higherGeography)

The locality data is listed from least to most specific, using commas to divide each detail. It is recommended to employ the English name in current usage where possible.

If there is a particular reason to use a different system, e.g. spelling/transcription variations or archaic names, such details should preferably be identified using quotes, **with their current names given in square brackets**, but this is not mandatory.

Geo-coordinates (decimalLatitude / decimalLongitude)

Diverse formats are accepted but it is important to include the degrees symbol (° [unicode: 00B0]), which distinguishes the data as a geo-coordinate. It is also preferable to include the direction (N/E/S/W):

Geo-coordinates should be presented to a maximum of 5 decimal places. Altitude/elevation/depth (verbatimAltitude / verbatimDepth)

This type of measurement should be explicit in the material citations, e.g.:

Collection date (eventDate)

Format: d(d) Mmm. YYYY

Date ranges should be shown with an n-dash, e.g.:

Jan.–Mar. 2018 / 5 Feb.–6 Apr. 2016 / 14 Dec. 2008–3 Feb. 2009 / 1950–1953

Collector (recordedBy)

The name(s) of the collector(s) should always be followed by "leg."; for institutions or collecting programmes, "exped." can be used, e.g. MNHN exped.

- degrees minutes seconds: 40°26'46" N, 79°58'56" W
- degrees decimal minutes: 40°26.767' N, 79°58.933' W
- decimal degrees: 40.446° N, 79.982° W
- Altitude: alt. 489 m or 547 m a.s.l.
- Depth: depth 20 m

For botanical and mycological data, "Collection number" instead of "collector [followed by "leg.]" . The collection number encompasses all gatherings from a single specimen (e.g., leaves, flowers, piece of wood) which may be preserved on different herbarium sheets and in different herbaria.

Additional data

Ideally, the data fields identified above should be listed before other collection data. If you choose to use a different order, it is important to be as consistent as possible throughout the paper, or at least within a single treatment. You may use a semicolon to separate the additional data into appropriate fields, e.g.:

Additional data can also be given in the appropriate field between brackets, e.g.:

Associated sequences

Accession numbers and barcodes should be identified as such, e.g.:

GenBank: U34853.1

Repository data (institutionCode / catalogNumber)

The repository data field should be composed of an institution acronym and a catalogue number (where available), using a colon to separate the two elements.

Institution acronym

All acronyms for repositories must feature in a distinct list in the Materials and Methods section, under the title Repositories, Institutional acronyms or Institutional abbreviations. Specimen code

The specimen/catalogue code(s) should be listed after the institution code.

Where a specimen code is available, it should be explicit which specimen it refers to. This guarantees unambiguous interpretation, both by readers and upon XML conversion.

E.g., in the citation below, we cannot distinguish which specimens are catalogued under which code:

NAMIBIA • 2 ♂♂, 4 imm.; Grootfontein, Nosib Cave; 8 Feb. 1995; SEGL leg.; SAMC B7732, B8870.

This citation should be presented as follows:

NAMIBIA • 2 ♂♂; Grootfontein, Nosib Cave; 8 Feb. 1995; SEGL leg.; SAMC B7732 • 4 imm.; same data as for preceding; SAMC B8870.

Exceptions:

1. If several specimens share the same code, e.g.:

SOUTH AFRICA • 2 ♀♀, 4 imm.; same data as for preceding; SAMC B8890.

2. If the specimens possess identical data, including the sex, their specimen codes can be given together, e.g.:

Ranges & multiple specimens

Use the word "to" in order to show a range of specimen numbers. E.g.:

NHMUK 213584 to 213595

Concise Copyediting Instructions

The copyediting instructions below represent a concise summary of the journal's formatting requirements. The instructions are intended for use by the authors during preparation of the final revised versions of their manuscripts, technical editors, copy editors and typesetters.

Author names

Omit titles, degrees, etc.

Provide ORCID if available Affiliation

(Department,) Institution, City, Country

Article title

Title of article: Subtitle of article

Title: Sentence case

Colon between title and subtitle (if any)

No footnotes

No bold (use when needed sub-/superscript, and/or italics only for the terms in Latin)

Higher taxa within the title should be separated with commas and not with a semicolon

Running head

A short version of title up to 50 characters (including spaces); normally the short title should have been suggested by the authors and checked for clarity by the copy editor Abstract

No references to tables, figures, etc., no footnotes

No citations (preferably)

- o If citations unavoidable: Complete citations, allowing unambiguous identification of cited publication!

Should be written consistently in either third or first person

Note: The abstract has to be a stand-alone entity, to present a really well written and concise summary of the article! A special care for copy editors to check!

Designations of nomenclatural novelties should be in bold and spelled in the way suggested (sp. nov., gen. nov., comb. nov.)

Keywords (up to 8 words)

keyword a, keyword b, keyword n

Do not repeat words from the title

Listed in alphabetical order and separated by commas Lowercase letters, except proper names

No bold font

Without any punctuation marks after last keyword

Tables

SOUTH AFRICA • 5 ♂♂; Windhoek, Daan Viljoen Game Reserve; 22°32'16.14" S, 16°54'44.16" E; 12 Aug. 2005; G. Binford leg.; NMNW 45845, 4590 to 4593 • 4 ♂♂; Northern Cape Province, Eselsfontein, south of Grootdrink; 28.62° S, 21.68° E; 13 Nov. 2005; M. Burger, P. Braad and A. Hill leg.; PPRI 2009/3830 to 3833.

Table caption: Start with label "Table N." in bold. Sentence case, i.e.:

- o Table 2. Table caption text.

Numbered consecutively with Arabic numerals

Heading for every column (including the leftmost!)

No shading of cells, rows, columns; no colored fonts

No horizontal or vertical lines in table body

Same number of decimal places for same statistics (usually within same column)

Text formatting in the cell without paragraph and line break

Table must be in an editable format (.docx, .xlsx, etc., not as images)

Caption and footnotes as texts (not as part of a table)

Figures

Figure caption: Start with label "Figure N." in bold. Sentence case, i.e.:

- Figure 6. Figure caption text.

Numbered consecutively with Arabic numerals

Figure parts: Use capital letters in bold. No punctuation separator, i.e.:

- Figure 1. Figure general caption text. A part caption text B part caption text N part caption text.

If abbreviations are used, these are placed after the parts with a colon, i.e.:

Abbreviations: xxxx

If there are scale bars on the figure parts, reference to them is last and in the format: Scale bars: 20 μm (D, N, O, Q); 50 μm (F, K); 10 μm (G, P); 5 μm (H); 100 μm (M).

High quality (at least 300 dpi)

Text sharp and readable (e.g., no overlap of text and graphical elements like lines)

White or transparent background

No image border

Caption as text (not as part of the image) Capitalization

Article title: Sentence case

Running head: Sentence case

Section and subsection titles:

- For separated titles (usually H1-H3): Sentence case

- For paragraph titles (usually H4): Sentence case

Table captions: Sentence case

Headings of table rows and columns:

- Sentence case or lower case (check for consistency only!)

Figure captions: Sentence case

In text body: Nouns followed by numerals/letters (citations of figures, tables, appendices and supplementary files) e.g.:

- Fig. 4; Figs 1, 2; Table 2; Appendix 1

In text body: Titles of articles, book chapters, books, tests

In references: Sentence case

Equations and statistical symbols

Typeface

- standard typeface for Greek letters, sub-/superscripts, and abbreviations that are not variables
- italic typeface for all other statistical symbols

Space before and after equal/inequality signs

Same number of decimal places for decimal values

Omit the zero before a decimal fraction, when the statistic cannot exceed 1, e.g., $p = .34$

- Alternative A: Omit the zero before a decimal fraction only for the following statistics: p , r , R (and R^2), α (Cronbach's α), η^2 (Eta-Square, also η_p^2).

- Alternative B: If zero is omitted before a decimal fraction, this should be done consistently for the respective statistic. Standard formats for common statistics, e.g., $t(23) = 3.51$, $p = .002$

- o commas (not semicolons!) between test statistics and p values
- o exact p values, if p not less than .001

Text body

Regular font usage:

- o Main text
- o Abbreviations e.g., i.e., et al., etc., cf., vs.
- o Greek letter e.g., α , β , γ , δ , ϵ , σ , φ , χ , ω

Italic font usage:

- o Scientific names of taxa of species and genera (authorities in regular font, not in italics)
- o Long direct quotations
- o Symbols for variables and constants, such as p, F, U, T, N, r, but not for SD (standard deviation), SE (standard error), DF (degrees of freedom), and NS (non significant).

These symbols in illustrations and equations should be in italics to match the text. o Do not use italics for emphasis

No underlining

Bold font usage:

- o Subheadings, sections and subsections
- o Figure captions – For the label and designation of figure's parts:

Figure 1. Figure general caption text. A part caption text B part caption text N part caption text. o Table captions – For the label:

Table 1. Table caption text.

- o In systematic sections for specimen designation such us: holotype, paratype, syntype, lectotype, isotype, etc.
- o Abbreviations of institutions or morphological characters or indices listed alphabetically in the section Materials and methods, i.e.:

NHML Natural History Museum, London MW Naturhistorisches Museum, Vienna EL length of elytra

EW maximum width of elytra

TL total length (PL+EL)

- o In species descriptions – designation of main anatomical structures followed by a colon mark, i.e. Head:..., Thorax:..., Legs:..., Abdomen:..., etc., in this case these should

be followed by a section describing other anatomical organs and structures attached to these.

- o Subsection "Specimens examined" - the preferred order is as follows, HOWEVER THESE FINE-GRAINED FORMATTING GUIDELINES ARE NOT COMPULSORY. Authors

who follow the guidelines will benefit from the submission of their specimen records to GBIF after publication. The records on GBIF will bear the article citation details contributing to a wider dissemination and re-use of the published data.

COUNTRY • specimens [e.g. 1 ♂, size]; geographic/locality data [from largest to smallest]; coordinates; altitude/elevation/depth [using alt./m a.s.l. etc.]; date [format: 16 Jan. 1998]; collector [followed by "leg."]; other collecting data [e.g. micro habitat/host/method of collecting]; barcodes/identifiers [e.g. GenBank: MG779236]; institution code and specimen code [e.g. CBF 06023].
For Example: Holotype: CHINA • ♀; Sichuan, Kangding; 30.04°N, 101.57°E; 15.VI.2017; Yanzhou Zhang leg.; Hyp-2018-06, original number ZYZ-2017-

28. Paratypes: CHINA • 1♀1♂; Sichuan, Kangding; 29.VI.2017; Yanzhou Zhang leg.; Hyp-2018-01, Hyp-2018-02, original number ZYZ-2017-08 • 1♀; Sichuan: Kangding; 2.VIII.2017; Yanzhou Zhang leg.; Hyp-2018-03, original number ZYZ-2017-20 • 1♂, Sichuan: Kangding; 29.VI.2017; Yanzhou Zhang leg.; Hyp-2018-08, original number ZYZ-2017-029.

Punctuation:

A bullet point "*" (unicode: 2022) is used to signify the beginning of a material citation. Within each citation, the different fields are delimited by a semicolon. A single field can be composed of several elements, which are separated by commas (e.g. the details region, area, town and street for the 'locality' field). Semicolons should not be used elsewhere in a material citation.

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see more details [here](#)

Quotation marks

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- Short quotations should be embedded in the text and enclosed in double quotation marks (""). Long quotations should be on a separate line, italicized, but without quotation

marks.

- Single quotation marks are to be used only for a quotation that occurs within another quotation.

Hyphen and dash characters

- Consistent use of (-, –, —).
- In contrast to parentheses an em-dash can be used alone. ○ En-dashes and em-dashes should not be spaced.

Section hierarchy

Hyphens (-) are used to:

link words such as personal names, some prefixes and compound adjectives (the last of which vary depending on the style manual in use)

En-dash (–) or en-rule (the length of an 'n') is used to: link spans.

link numerals, sizes, dates and page numbers (e.g., 1977–1981; figs 5–7; pp. 237–258)

geographic or name associations (e.g., Murray–Darling River; a Federal–State agreement) character states combinations (e.g., long–pubescent or red–purple).

Em-dash (—) or em-rule (the length of an 'm') should be used rarely:

only for introducing a subordinate clause in the text that is often used much as we use parentheses.

No more than 4 levels, from hierarchical level 1 (H1) to hierarchical level 4 (H4)

Unambiguous hierarchy levels

No numbering of hierarchical levels

Section titles

Capitalization:

- For separated titles (usually H1-H3): Sentence case
- For paragraph titles (usually H4): Sentence case

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The author has no funding to report.

The authors have no funding to report. Competing interests

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Geographical coordinates

One of the following formats should be used:

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Degrees and Decimal Minutes (DDM), i.e.:

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- 36.5243°S; 114.1641°W

- -36.5243; -114.1641 (using minus to indicate southern and western hemispheres) In-Text Citations

References

- 1-2 authors

Jackson and Miller (2012) found out that...

A recent study (Jackson and Miller 2012) confirmed that... ○ 3 or more authors

Jackson et al. (2012) found out that...

A recent study (Jackson et al. 2012) confirmed that... ○ Multiple sources in chronological order:

same authors different years - separated by a comma:

Jackson and Miller (2012, 2015) found out that...

Recent studies (Jackson et al. 2012, 2015) confirmed that...

different authors - separated by a semicolon:

(Smith et al. 1998, 2000, 2016; Brock and Gunderson 2001; Felt 2006)

two or more fully identical citations (the same authors and years) are distinguished by adding the letters 'a', 'b', 'c', etc. after the year: Jackson 2008a, 2008b

Jackson and Miller 2014a, 2014b

Reyes-Velasco et al. 2018a, 2018b ○ Sources with page numbers

Jackson and Miller (2012: 120–121) found out that

A recent study (Jackson and Miller 2012: 120) confirmed that

Figures:

- Fig.1
- Fig. 1A, B
- Fig. 1A–D
- Figs 1, 2
- Figs 1–3
- Figs 1A, B, 3F, G, 7A

Tables:

- Table 1
- Tables 1, 2
- Tables 1–3 Appendixes:
- Appendix 1
- Appendices 1, 2 ○ Appendices 1–4

Referenced materials from other sources:

- All figures, tables, etc., from other sources should be written with small letters i.e.: see fig. 2 in Author (Year) ...

References

Author names: surname first; all given names abbreviated, no full stops, commas or spaces, i.e.: ○ Lyal CHC

- van Tol J
- de Albuquerque PRA

Different authors separated by comma
Year in brackets; no comma or full stop after it
No italics (except for Latin terms)

Published papers:

Polaszek A, Alonso-Zarazaga M, Bouchet P, Brothers DJ, Evenhuis NL, Krell FT, Lyal CHC, Minelli A, Pyle RL, Robinson N, Thompson FC, van Tol J (2005) ZooBank: The open-

access register for zoological taxonomy: Technical Discussion Paper. Bulletin of Zoological Nomenclature 62: 210–220.

Accepted papers:

Same as above, but "in press" appears instead of the year in parentheses.

Electronic journal articles:

Mallet J, Willmott K (2002) Taxonomy: Renaissance or Tower of Babel? *Trends in Ecology and Evolution* 18(2): 57–59. [https://doi.org/10.1016/S0169-5347\(02\)00061-7](https://doi.org/10.1016/S0169-5347(02)00061-7) Paper within conference proceedings:

Orr AG (2006) Odonata in Bornean tropical rain forest formations: Diversity, endemism and applications for conservation management. In: Cordero Rivera A (Ed.) *Forest and*

Dragonflies. Fourth WDA International Symposium of Odonatology, Pontevedra (Spain), July 2005. Pensoft Publishers, Sofia-Moscow, 51–78.

Book chapters:

Mayr E (2000) The biological species concept. In: Wheeler QD, Meier R (Eds) *Species concepts and phylogenetic theory: A debate*. Columbia University Press, New York, 17–29.

Books:

Goix N, Klimaszewski J (2007) *Catalogue of Aleocharine Rove Beetles of Canada and Alaska*. Pensoft Publishers, Sofia-Moscow, 166 pp.

Book with institutional author:

ICZN [International Commission on Zoological Nomenclature] (1999) *International code of zoological nomenclature*. Fourth Edition. The International Trust for Zoological

Nomenclature, London.

PhD thesis:

Dalebout ML (2002) *Species identity, genetic diversity and molecular systematic relationships among the Ziphiidae (beaked whales)*. PhD Thesis, University of Auckland, Auckland,

pp.

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