THE CERATOPOGONIDAE INFORMATION EXCHANGE

The CIE, issued twice a year (no subscription fee), was begun in 1968 as a newsletter to facilitate communication among workers interested in the Ceratopogonidae. The format is extremely flexible. Contributions may be of any length and deal with any subject having some bearing on the study of ceratopogonids. For example, contributors may report their current interests or plans, observations or techniques of probable value to the readership, requests for addresses, study material or reprints, or any other matter of concern. The newsletter serves also as a bulletin for planning and communicating information on meetings, symposia, workshops and so forth. Finally, there is in every issue a compilation of recent literature in the field. Any person(s) wishing to contribute to the newsletter or to receive future issues by email should contact:

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CIE No. 103 – May 2019 - The Ceratopogonidae Information Exchange Newsletter

Research Colleagues,

It is my hope that this May, 2019 issue of the CIE Newsletter will assist you in your various research projects and help broaden your knowledge about ceratopogonids. The Recent Literature section contains citations of <u>126 original research</u> <u>papers, reviews, books, reports, and letters</u> representing diverse research areas. I have again included <u>figures with</u> <u>images</u> from two of these papers on the last pages of this issue.

In my opinion, the most creative title of a paper in this issue begins with "*Culicoides* Latrielle in the Sun…" by <u>Garros et al.</u> Also, a significant work cited in this issue deals with the phylogenetic relationships of Cretaceous biting midges (<u>Borkent, 2019a</u>) in which the author describe a new genus, *Gerontodacus* ("old one"; "biter"). Many thanks to all who kindly sent material to be included in this issue.

If anyone is not listed in the <u>Directory of Workers</u>, please send your contact information (or an update) to me. Lastly, please also send copies of your published papers, research

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summaries, requests for information, etc. to me for the December, 2019 issue by Friday, Dec. 6th.

With Kind Regards, Steve Murphree, Nashville, Tennessee, U.S.A.

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Obituary

In Memory of **Sujit Kuman Das Gupta** (January 1, 1933 - December 28, 2018) **Submitted by: P. K. Chaudhuri**

Prof. Sujit Kumar Das Gupta received his B.Sc Honors degree in Zoology in 1952, M.Sc. in Zoology with specialization in Entomology in 1954 and Doctor of Science in 1965 from Calcutta University. After a short stint of research in the School of Tropical Medicine, Calcutta with noted research scientists, he accepted teaching assignments at the respected Government Colleges of State of West Bengal. After completing his thesis for the D.Sc. degree, he went to the United States of America in 1964 to work at the Smithsonian Institution, Rutgers University and the University of Maryland in collaboration with Willis W. Wirth, D. H. Messersmith, William L. Grogan, Jr. He was also in touch with many research scientists such as Art Borkent and other visiting entomologists. After returning to India, Dr. Das Gupta joined the faculty of well-known Government Colleges such as Hooghly Mohosin, Darjeeling Government and



Presidency Colleges, where he served as Professor and Head of the department until 1998. The research publications of Prof. Das Gupta can be found in the References at the end of the latest catalog, <u>World Species of Biting Midges (Diptera: Ceratopogonidae</u>, complied by Art Borkent. Quite a number of graduate had the opportunity to work with Dr. Das Gupta for their Doctoral degrees.

[Editor's Note: Please see the <u>Contributions from Scientists</u> section about studies on Indian ceratopogonids in the May, 2011 issue of this newsletter.

From P.K. Chaudhuri, who submitted this summary, also stated, "My indebtedness to him knows no bound and what I have achieved in research is only for that great man."

From Art Borkent: "Sujit Das Gupta was the only ceratopogonid taxonomist in India for many years and founded a group of students who continue the work today. His work on the *Stilobezzia* of the Oriental Region is an excellent comprehensive publication that laid the groundwork for this group in that area. His taxonomic works include 25 major contributions and he coauthored descriptions of 265 new species. He published other important papers on ceratopogonid behaviour as well. He will be missed."]

In Memory of Alan Lindsay Dyce (September 6, 1923- January 4, 2019) Submitted by: Glenn Bellis



Alan Dyce held a special place amongst vector entomologists around the world. His pioneering work on the study of biting midges as vectors, particularly field collection, recognition of parous females and taxonomy, continues to inspire entomologists today.

Alan was born in the NSW country town of Coolamon and grew up on a farm in the Riverina district. He attended Yanco Agricultural High School which helped formalise his interest in everything rural. After leaving school he enlisted in the navy and served as a radar operator on N class Destroyers, working out of Darwin until the end of World War II. He met his wife, Hilda, prior to enlisting and they managed to maintain their relationship during his service, eventually marrying in 1948.

Immediately following his service, Alan enrolled in a Bachelor of Science in Agriculture from which he graduated with First Class Honours majoring in entomology in 1952. He was immediately employed by CSIRO as a research Officer and within weeks was seconded to the CSIRO Wildlife Survey Section to work on the vectors of myxomatosis of rabbits. This introduction to vector-borne diseases proved to be a turning point in Alan's career and remained a focus for his entire life. It was during these nine years working alone in northern NSW that Alan first discovered biting midges. The fact that these prominent biting flies in the field had been so neglected by science intrigued Alan and before long he was hooked on them and became determined to address that deficiency.

After the completion of the myxomatosis program in 1961, Alan was transferred to the Division of Entomology in Canberra but quickly had himself transferred to the Division of Animal Health, McMaster Laboratory in Sydney, to work on insect-borne diseases of livestock. Initially he worked with Durno Murray carrying out surveys for biting midges across eastern Australia in the 1960s. At this time, authorities were concerned about the exotic threat of bluetongue disease which had devastated merino sheep flocks in the Iberian Peninsula in the 1950s. Bluetongue was known to be transmitted by *Culicoides* biting midges but very little was known about the biology and distribution of biting midge species in Australia or the potential impact of bluetongue on Australia's merino flocks.

In the late 1960s, there was a quarantine incident on the outskirts of Brisbane when it was found that bull semen had been illegally imported from an area where bluetongue disease occurred. As part of the response, Alan Dyce came to Brisbane to assist with collecting biting midges, and it was here that he met two scientists who would become lifelong friends and colleagues, mosquito specialist Harry Standfast and veterinarian and microbiologist Toby St George from the CSIRO Long Pocket Laboratories in Brisbane. Together this team would change the face of veterinary arbovirus research in Australia. Harry and Alan worked across northern Australia pioneering methods of collecting, feeding, identifying and preparing midges and mosquitoes for the virus isolation studies headed by Toby. So simple and effective were these methods that they were quickly adopted by researchers the world over and many continue to be used today. Toby was also the driving force behind the establishment of a sentinel herd serum bank that covered much of Australia.

Following their discovery in 1977 of bluetongue virus silently circulating in cattle in northern Australia, the team led by Alan, Harry and Toby identified the vectors, clarified the distribution and ultimately provided an explanation for the limited distribution of this virus and the reasons the Australian sheep flock, mostly in the southern and inland regions of Australia, was not affected by this disease at that time. Their work has since been adopted by the National Arbovirus Monitoring Program (NAMP) which maps the distribution of livestock arboviruses and their vectors allowing authorities to declare infected and free zones, greatly facilitating the trade of livestock to markets sensitive to Australian viruses. This program relies on a team of entomologists who rely either on training received from Alan, or on identification aids prepared by him. Alan personally acted as the Reference Entomologist to NAMP well into his 80's.

Towards the end of his career with CSIRO, Alan turned his hand to taxonomy but being the holistic naturalist that he was, his taxonomic studies were based on broad disciplines encompassing biogeography, morphology as a product of biological necessity, host preferences and, especially, immature breeding habitats. His influence is evident in vector and taxonomic studies in Africa, SE Asia and the Americas via his collaboration with eminent experts such as Willis Wirth, Michel Cornet and Rudy Meiswinkel. Alan's goal of revising the entire Australasian *Culicoides* fauna proved to be too ambitious for a single lifetime but in 2007 he completed a wing picture atlas which comprehensively treated the entire fauna, much of which was collected by Alan and his team. His generosity in sharing both his knowledge and his time was renowned and many a researcher owes a debt of gratitude to Alan for his contributions and ideas. This willingness to assist others with their projects probably distracted Alan from completing his own revisionary work but his assistance on compiling wing picture atlases of the *Culicoides* of the Americas, a monograph of the *Culicoides* of SE Asia and a complete revision of the Australian true sandflies (Phlebotominae) are now part of his legacy.

Alan's eminence as Australia's foremost veterinary vector entomologist was acknowledged formally on two occasions when he received an Order of Australia medal in 2004 and again in 2008 when he received the Australian Medal for Agricultural Science from the Australian Institute of Agricultural Science and Technology. He was particularly proud of this latter achievement.

Alan's conclusion that the vectors of bluetongue virus in Australia were all of Asian origin led him to collaboration with workers in Asia, including the Japanese midge expert, Masaaki Tokunaga. At the end of a trip to Japan to visit Dr Tokunaga and his colleagues, Dr Tokunaga, who had served in the Japanese Armed Forces during World War II, shook Alan's hand and pronounced "Once we were enemies but now we are friends".

At the McMaster Laboratory, Alan had a magazine clipping on his microscope cabinet that said "There's more to seeing than looking". His career was the epitome of that saying. When not studying his beloved *Culicoides*, Alan enjoyed fly fishing in the Snowy Mountains and tending his garden at his house in Asquith, northern Sydney. Alan is survived by his son, Lindsay, and two granddaughters Peta and Megan.

[Editor's Note: The memoirs of Alan Dyce were included on pages 17-19 of the <u>December, 2012 issue</u> of this newsletter.

Additional comments from Glenn Bellis: "Alan was an integral part of the team that pioneered many of the methods routinely used in arbovirology today, the most notable of which is probably the method of separating parous and nulliparous female *Culicoides*, a paper that must have been cited hundreds of times. His work on establishing systems to collect vectors, test vector competence, recognise the importance of immature habitats and his taxonomic work have formed a framework that many workers continue to build on around the world today. For those that knew him personally, his generosity, curiosity, honesty and incredible knowledge were an inspiration."

From Art Borkent: "Alan was instrumental in so many aspects of understanding Ceratopogonidae biology. He had a wealth of knowledge about our family and he helped me with numerous aspects of studying *Austroconops* in Western Australia. My correspondence with him was voluminous, including many letters of 4-5 or more pages, packed with important information and observations. He knew the importance of studying the whole organism - a rare perspective. I will miss him!"

From Yehuda Braverman: "Some additions to Alan Dyce's scientific activities. During his study tours in the world he visited Israel twice. Once in the late sixties when I started to work on *Culicoides* at the Kimron Veterinary Institute, we went together on several field trips to find the breeding sites of *C. imicola*; at that time he was convinced that *C. imicola* breeds in cow pats. In his second visit in the early nineties the emphasis was the *C. schultzei* complex that he was eager to study, as Israel is a cross road between the Palearctic and the Ethiopian fauna. He proved himself to be the best field man, with very wide biological knowledge, that I ever met."

From Steve Murphree: Though I never had the pleasure of meeting Alan, I so appreciated receiving his letters which included our correspondence about the larvae and larval habitats of *Culicoides* species. I know that Alan was also a very good friend to our late research colleague, Valentina Glukhova, supporting her in every possible way, including on one occasion sending a monetary gift to be handed to her by a 'trusted tourist'. As a way of illustrating his skill as a field researcher I include a note from a Christmas card I received in 1995: "Since writing I caught up with a healthy population of *Culicoides rabauli* larvae and am still link rearing them. From a tree hole on the old farm 316 M west of Sydney – where I was born and reared. I know every tree on the farm and planted many of them as a youth prior to enlisting in the RA Navy. I've decided that the larval long hairs (caudal setae) – a biological advantage in the process of pupation – have more than likely evolved in parallel. Just the same, *C. rabauli* should be checked out against the Russian *Amossovia* and the Nearctic *Guttipennis* Group."]



Figure 1. Alan Dyce preparing to make a biting insect bait collection from a buffalo, Mudginberri Station, NT, 1970.



Figure 2. Alan Dyce checking the catch in upper and lower truck trap collection bags, Beatrice Hill, NT 1978. There was no difference, so the standard truck trap became a single large net.



Figure 3. Alan Dyce and technical officer Dean Gibson collecting cassowary dung on the Atherton Tableland, Queensland, looking for breeding by *Culicoides actoni*.



Figure 4. Alan Dyce lecturing at a Culicoides workshop, Long Pocket Laboratories, Brisbane, Queensland, 1992.



Figure 5. Hilda and Alan Dyce at a breakfast at Easter, 1996.

Announcements

2019 Field Meeting of North American Dipterists Society (NADS) 3-7 June 2019, Bull Shoals Field Station, Missouri, Final Announcement

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This is a final reminder for the next NADS field meeting, which is scheduled for 3-7 June, 2019, at Bull Shoals Field Station (BSFS). BSFS is in southwestern Missouri, a short drive from Branson and near the Arkansas border. The station and surrounding areas offer a wide variety of ecosystems, which serve as habitat to a diverse assemblage of Diptera. The station has Ozark



upland forests (oak-hickory dominant), glades, grasslands, old fields, managed food plots, as well as aquatic habitats. Aquatic habitats include naturally occurring woodland ponds, man-made ponds, streams, springs, and a large reservoir (Bull Shoals). Nearby areas include the Buffalo National River and Ozark – St. Francis National Forest to the south (Arkansas) and Mark Twain National Forest to the north and east (Missouri). These areas expand collecting option even more, to include fens and additional large springs and rivers. Also note that we will set several Malaise

traps a week before the meeting, so we should have plenty of interesting material to examine and identify at the start of the meeting.

Please see the BSFS website for additional information: https://bullshoals.missouristate.edu/. Weather during the meeting is likely to be hot (85-90°F). Biting insects, ticks and chiggers, and poison ivy are abundant at BSFS so use of personal protective measures is highly recommended. Venomous snakes also occur in the area, and include pygmy rattlesnakes (common), timber rattlesnakes (common), cottonmouth (occasionally present along waterways, but not known from BSFS), and copperhead (abundant). Potentially dangerous arthropods include black widow spiders (common), brown recluse spiders (abundant), and striped bark scorpions (uncommon).

Collecting permit information

Collecting permits are NOT needed for the Bull Shoals Field Station.

State of Missouri

1. State parks. Permits are required in the form of written permission from the Director. There is no fee. Allow 2-3 weeks for processing. Contact

christopher.crabtree@dnr.mo.gov, Missouri Department of Natural Resources, **or** David Bowles, who can supply you with the required application form.

1. Conservation lands – Missouri Dept. of Conservation. A permit is required for collection of aquatic invertebrates (other than mollusks or crayfish) and terrestrial invertebrates only if you are collecting Species of Conservation Concern or if you are collecting on Missouri Department of Conservation lands. Permit applications can be found at: https://huntfish.mdc.mo.gov/permits/wildlife-collector-permits. Permit fee is \$5:00.

State of Arkansas

1. State Parks – Arkansas Department of Parks and Tourism (State Parks). No charge for the permit but they will want to know the specific parks where collecting will occur. A report required is required and a list of species collected will suffice. Allow up to 6 weeks to process application. Contact David Bowles who can send you the proper form.

2. Other state conservation lands and general collecting in Arkansas. Arkansas Game and Fish Department. A permit is required. No fee is assessed. No report required. Allow 4-6 weeks for completion. Permit application can be found at:

https://www.agfc.com/en/resources/wildlife-conservation/scientific-collection-permits/

Federal Lands

1. US National Forest – no permit is required for personal collecting. A permit is required for commercial collecting. Exceptions are protected area such as campgrounds, and unique features such as caves.

2. Buffalo National River, Arkansas – US National Park Service permit required and strictly enforced. Obtain permit from Buffalo National River. Contact Charles Bitting at chuck_bitting@nps.gov.

3. Ozark National Scenic Riverways, Missouri – US National Park Service permit required and strictly enforced. Obtain from Ozark National Scenic Riverways. The permit application can be found at: https://irma.nps.gov/rprs/

Tentative Schedule:

Monday, 3 June (late afternoon / evening): Check-in at BSFS, possible collecting nearby. Dinner on your own, followed by welcome and introduction to area.

Tuesday-Wednesday, 4-5 June: Breakfast on your own. Field excursions. Dinner on your own, followed by informal presentations, sorting of the day's collections, and general camaraderie.

Thursday, 6 June: Schedule similar to Tuesday & Wednesday, except dinner (barbeque) @ BSFS (Drury House).

Friday, 7 June: Breakfast on your own, and check-out.

Logistics: Participants who fly are advised to fly to Springfield-Branson National Airport (SGF), then arrange for a rental car. SGF is on the northwest side of Springfield and approximately 65 miles from BSFS (1-1.5 hours). There is also a small airport just south of Branson, but it serves only Frontier Airlines.

Logistics: Participants who fly are advised to fly to Springfield-Branson National Airport (SGF), then arrange for a rental car. SGF is on the northwest side of Springfield and approximately 65 miles from BSFS (1-1.5 hours). There is also a small airport just south of Branson, but it serves only Frontier Airlines.

Cost: There will be a conference fee of \$40, payable in cash when you arrive at BSFS (receipts can be provided). This fee will cover the use of the BSFS classroom & laboratory, the cost of the Thursday night barbeque, and incidentals.

Accommodation costs include the following options.

- 1) \$10/day/person for participants staying in either of the BSFS houses. Note again that this includes shared rooms and bunk beds, with a total of 24 beds. To make reservations for a room, please contact David Bowles.
- 2) \$5/day/person to camp at either BSFS house or on other BSFS property. This will include access to showers and kitchens inside the house. Again, these should be arranged through Dr. David Bowles.
- 3) Non-BSFS accommodations include numerous motels in Branson.

Specific questions about BSFS or other accommodations can be directed to David Bowles.

Attendee list & presentations: If you plan to attend the meeting, please email Greg Courtney or David Bowles so we can add you to the attendee email list. Also let Greg know if you are interested in giving a presentation, so we can add you to the schedule... and please send a title. THANKS.



27th Conference of the World Association for the Advancement of Veterinary Parasitology JULY 7 – 11, 2019 | MADISON, WI, USA

The Livestock Insect Workers Conference and the American Association of Veterinary Parasitologists will meet jointly with the World Association for the Advancement of Veterinary Parasitology at its conference July 7-11, 2019 at the Monona Terrace Convention Center (designed by Frank Lloyd Wright) in Madison, Wisconsin. The theme of the Conference is "Sifting and Winnowing the Evidence in Veterinary Parasitology" More information can be found at: <u>http://www.waavp2019.com/</u>.

Contributions/Requests from Scientists:

From: Emma Howson and Simon Carpenter, The Pirbright Institute, Pirbright, Woking, Surrey, UNITED KINGDOM (<u>emma.howson@pirbright.ac.uk</u>; <u>simon.carpenter@pirbright.ac.uk</u>)

The Gnatwork: An Update

We are nearly two years into our Global Challenges Research Fund (GCRF) grant, the Gnatwork, which brings together researchers on blackflies, sandflies and biting midges. Currently a network of 244 researchers, spanning 52 countries worldwide, we are working towards creating a more collaborative and resilient research base for these three neglected vector groups.



One of our key successes to date has been our Bangladesh '18 international workshop, held in collaboration with the International Centre for Diarrheal Disease Research, Bangladesh (<u>icddr,b</u>). Following a day of conference talks and posters in Dhaka, we held a four-day training workshop for early-career researchers, which was led by members of the Gnatwork Management Board and invited



experts, Dr Lara Harrup and Glenn Bellis. We ran a variety of training sessions, from interactive seminars on basic experimental design and statistical methods, through to practical sessions on trapping techniques, identification, DNA Barcoding and slide mounting. Protocols from our workshops practical sessions are now freely available on our website. Our next international conference and workshop will be held in Belo Horizonte, Brazil (November 2019), in collaboration with the Federal University of Minas Gerais. Similar to Bangladesh '18, we will have a travel bursary scheme in place to support 20-30 early-career researchers from countries receiving Official Development Assistance (ODA); updates on this can be found on our website (www.gnatwork.ac.uk).

To enhance links between researchers, the Gnatwork has funded two competitive calls to date to support collaborative small-scale projects which link to countries receiving ODA. Our first pump-prime funding call "Validation", held in 2018, funded projects which focused on the development of

techniques suitable for use across vector groups. From this, three projects were funded: (i) the use of FTA cards to measure infectiousness, (ii) immunomarking for studies of vector dispersal and (iii) field testing of a portable sequencer for disease surveillance. For our second funding call "Transformative Science", we have now selected two successful proposals which focus on areas of blue-sky science; details of these projects will be released in June.

We are excited to announce that we will be opening a final funding call at the end of May, the Gnatwork Community Call, which will be driven by Gnatwork members. Based on a number of key research gaps the Gnatwork Management Board have identified, the community will get to vote for the projects they believe will be most beneficial. The projects with the most votes will be released on the Gnatwork website for applications, where it will be up to you to put together a team with the expertise required to fulfil the project aims. Projects must: (i) be 6 months in total, (ii) start by the 1st December, (iii) be led by a UK-based researcher, (iv) link to researcher(s) in a country receiving ODA and (v) be up to £50,000. To receive updates, vote for the projects and apply to conduct the studies, join the Gnatwork at www.gnatwork.ac.uk.



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Recent Literature:

Taxonomy and Morphology

- Anjos-Santos, D., F. Diaz, G. R. Spinelli, and M. M. Ronderos. 2018. The immatures of *Bezzia chilensis* Spinelli & Ronderos, 2001 (Diptera, Ceratopogonidae). <u>Zookeys 803:141-154</u>.
- **Borkent, A. 2019a.** The phylogenetic relationships of Cretaceous biting midges, with a key to all known genera (Diptera: Ceratopogonidae). <u>*American Museum Novitates* 3921: 1-48.</u>
- **Borkent, A. 2019b.** The Lower Cretaceous Male of *Lebanoculicoides daheri* Belonging to the Earliest Lineage of Biting Midges. *Canadian Entomologist* 151(3): 278-290 [Abstract & References].
- Brahma, S., and N. Hazra. 2018. Additions to the species of *Dasyhelea* Kieffer, 1911 (Diptera: Ceratopogonidae) from West Bengal, India. *Polish Journal of Entomology* 87(4): 349-369.
- Cen, C.-H., Z.-Y. Xu, X.-J. Han, Q.-Q. Chang, C. Duan, and X.-H. Hou. 2018. Molecular identification of three species in subgenus *Culicoides* (Diptera Ceratopogonidae *Culicoides* Latreille) based on the mtDNA-co i gene. *Jishengchong Yu Yixue Kunchong Xuebao* 25: 37-45.
- Diaz, F., C. Mangudo, G. R. Spinelli, R. M. Gleiser, and M. M. Ronderos. 2018. The Immatures of Culicoides trilineatus (Diptera: Ceratopogonidae) Potential Vector of the Bluetongue Virus. Journal of Medical Entomology 55(4):877-883 [Abstract].

- Diaz, F., C. Mangudo, R. M. Gleiser, and M. M. Ronderos. 2019. Redescription of immatures of Dasyhelea flavifrons Guerin-Mineville (Culicomorpha: Ceratopogonidae) and new contribution to the knowledge of its larval habitats. <u>Anais Da Academia Brasileira De Ciencias 91(1):</u> <u>e20180047: 1-14.</u>
- Duan, C., X. H. Jiang, Q. Q. Chang, and X. H. Hou. 2019. First description of the immature stages of Dasyhelea alula and a redescription of adults from China (Diptera, Ceratopogonidae). <u>Zookeys</u> <u>824: 135-145</u>.
- Duan, C., Q.-Q. Chang, Y. Luo, H.-F. Zhou, and X.-H. Hou. 2018. Geometric Morphometric Analysis of Wing Shape Variation of Three Species in Subgenus Avaritia (Diptera Ceratopogonidae Culicoides). Jishengchong Yu Yixue Kunchong Xuebao 25: 148-153.
- Felippe-Bauer, M. L. 2018. Two new species of *Atrichopogon* Kieffer from Acre State, Brazil (Diptera: Ceratopogonidae). *Zootaxa* 4532(2): 257-265 [Abstract & References].
- Foxi, C., C. Contini, and G. Delrio. 2018. Contribution to the Knowledge of Biting Midges (Diptera Ceratopogonidae) of Sardinia, Italy. *Redia-Giornale Di Zoologia* 101: 137-141.
- Garros, C., K. Labuschagne, L. Dommergues, M. s. Ben, T. Balenghien, F. Munoz, M. T. Bakhoum, E. Cardinale, and H. Guis. 2019. *Culicoides* Latreille in the sun: faunistic inventory of *Culicoides* species (Diptera: Ceratopogonidae) in Mayotte (Comoros Archipelago, Indian Ocean). <u>Parasites & Vectors 12: 135.</u>
- Gatt, Paul. 2015. The Family Ceratopogonidae (Diptera: Nematocera) in Malta. <u>Bulletin of the</u> <u>Entomological Society of Malta 7:113-119</u>
- Gusmao, G. M. C., G. A. Brito, L. S. Moraes, M. Bandeira, and J. M. M. Rebelo. 2019. Temporal Variation in Species Abundance and Richness of *Culicoides* (Diptera: Ceratopogonidae) in a Tropical Equatorial Area. *Journal of Medical Entomology* <u>https://doi.org/10.1093/jme/tjz015</u> [Early View Abstract].
- Jiang, X. H., X. J. Han, Q. Y. Liu, and X. H. Hou. 2019. The mitochondrial genome of *Forcipomyia* makanensis (Insecta: Diptera: Ceratopogonidae). <u>Mitochondrial DNA Part B-Resources 4(1):</u> <u>344-345.</u>
- Oke, P. O., O. M. Samuel, E. Oke-Egbodo, J. O. Adejinmi, and D. O. Oluwayelu. 2019. Wing vein shape signal in *Culicoides oxystoma* (*Schultzei* group) in Nigeria Tool for discrimination (Diptera: Ceratopogonidae) using geometric approach. *Zoologischer Anzeiger* 279: 26-37 [Abstract].
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- Wang, C.-C., M. Chen, M.-Q. Yang, L.-Q. Pan, X.-Y. Yun, and E.-J. Huang. 2018a. Application of RDNAits Gene Sequence in Molecular Identification of Biting Midges. *Jishengchong Yu Yixue Kunchong Xuebao* 25: 92-100.
- Wang, C.-C., M. Chen, A.-P. Zheng, L.-Q. Pan, X.-Y. Yun, and E.-J. Huang. 2018b. Phylogeographic Studies on *Culicoides arakawai* from Both Sides of Taiwan Straits. *Jishengchong Yu Yixue Kunchong Xuebao* 25: 28-36.
- Yildirim, A., B. Dik, O. Duzlu, Z. Onder, A. Ciloglu, G. Yetismis, and A. Inci. 2019. Genetic diversity of *Culicoides* species within the *Pulicaris* complex (Diptera: Ceratopogonidae) in Turkey inferred from mitochondrial COI gene sequences. *Acta Tropica* 190: 380-388 [Abstract].

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Ecology and Methodology

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Fig. 3. Comparison of abundance of 10 *Calicoides* spp. in (A) total trap counts of all physiological statuses, (B) bloodmeals on white-tailed deer and (C) aspirations from white-tailed deer. These data were recorded from a big game preserve in Gadsden County, FL, from July 2015 through to September 2016.

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