

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. 105 –May 2020 -The Ceratopogonidae Information Exchange Newsletter

Research Colleagues,

I hope that this issue of the CIE Newsletter finds you in good health during this challenging period of our history. I am thankful for the help of a Vanderbilt University science librarian in searching databases for recent literature due to COVID-19 library closures. We are saddened by the loss of our colleague, Michel Kr  mer, who made significant contributions to our science and whose obituary and photographs appear in this issue. The Recent Literature section contains citations of 54 original research papers, reviews, books, reports, and letters representing diverse areas of research. I have again included figures with images from five 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 "Living la Vida T-LoCoH ..." by Dihn et al. Also, a significant work (94 pp.) cited in this issue is a revision of Neotropical predaceous midges in the genus *Downeshelea* (Santar  m et al.) in which 18 new species are described. My thanks to all who sent material to be included in this issue.

If anyone is not listed in the Directory of Workers, please send your contact information (or an update) to me. Lastly, please also send copies of your published papers, research summaries, requests for information, etc. to me for the December, 2020 issue by Friday, Dec. 4th.

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

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New CIE Newsletter Subscribers

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Obituary

In Memory of Michel Krémer (1936- March 27, 2020)

Submitted by: Glenn Bellis and Claire Garros, with help from John Boorman, Shahin Nawai and Bruno Mathieu

Professor Michel Krémer, Honorary Professor at the School of Medicine at the University of Strasbourg, Officer of the Order of Academic Palms, Knight of the Order of Agricultural Merit, passed away 27th March 2020 at 84 years old. He is survived by: Madame Monique Krémer, his wife; Doctor Eric Krémer and his wife Anne; Madame Valerie Klumb and her husband Daniel; Mister Quentin Krémer and his wife Elisabeth; his grandchildren, their spouses and his great- grandchildren.



Professor Michel Krémer was the second Director of the Institute of Parasitology and Tropical Pathology of Strasbourg (IPPTS), founded by Jacques Callot in 1961. During his tenure as Director of IPPTS, Professor Krémer developed a program of internationally renowned entomological studies and founded a unique entomological reference collection of *Culicoides* species.

The President of the University of Strasbourg and the Dean of the School of Medicine wrote:

“Very invested in his three statutory roles as teacher, researcher and hospital practitioner, Professor Krémer was also strongly involved in institutional life by being a member of the council of the Faculty of Medicine and as an assessor of the Dean in 1979 and 1980. In the field of research, he assumed the role of Director of the Institute of Parasitology and Tropical Pathology. In addition, he was appointed as a corresponding member of the National Museum of Natural History as well as the Royal Academy of Overseas Sciences of Belgium.”

From John Boorman, Guildford, Surrey, United Kingdom:

I was greatly saddened to hear about Michel. He was one of a (sadly) diminishing band of *Culicoides* experts from the early '50s to the late '70s.

I got to know him quite well; he had a great sense of humour and was always very generous with help and loan of specimens. Our family (myself, wife and three children) spent a very enjoyable holiday in Strasbourg with Michel and Monique, following which our two teenage sons exchanged visits. He was one of the pioneers of research into the biology of midges, and his monograph on the *Culicoides* of France and neighbouring countries was the foundation and inspiration of much of what we know today. He will rightly be remembered as one who laid the foundations of midge studies in the whole of Europe.

From Shahin Nawai, Berlin, GERMANY:

In memory of Prof. Michel Krémer:

I first met Michel Krémer in 1974, at the workshop of international ceratopogonidologists in Strasbourg. At that time I studied at the University of Maryland with Paul Bystrak, Bill Grogan, Joyce Utmar and Bill Waugh under the supervision of Don Messersmith, and Bill Wirth at the Smithsonian Institution. From this group Bill Grogan, Bill Wirth and I attended the workshop, which was held at the Institute de Parasitologie et de Pathologie Tropical de Strasbourg. Michel was the director of the Institute and the workshop was well planned, with a very friendly and warm atmosphere. For me, also visiting the stable colonies of *Culicoides* was interesting since in Iran with G. Nakata at Razi Institute we could not rear *Culicoides puncticollis*. One day I worked in the collection room and compared some species from Africa with my specimens from Southwest Asia.

At the end of the workshop, Michel and Monique invited us for a wonderful French dinner at their home, a night to be remembered for their special hospitality. When I finished my Ph.D. I went back to Iran where I started to work in the School of Hygiene at Tehran University. Shortly afterwards, my international connection was cutoff completely due to stupid politics and crises of the new government.

A few years later, when I was out of Iran, I wrote Michel and asked for his help to find a job in Europe. During the 1990s I traveled to Strasbourg two times and visited Monique and Michel on both occasions. I invited them to Berlin but Monique did not like to travel and did a lot of glass painting.

The last time I visited Michel at his Institute was just before his retirement. He seemed sad that in the future no one would be working there and taking care of the collection. But, I am glad that Bruno Mathieu started a few years ago and is working today at the same institute.

[Below is a photograph of Michel and Monique Kremer with Shigeo Kitaoka that was submitted by Shahin Navai and was taken in Strasbourg on 4 September 1986 – Ed]



Announcement

Cancellation of the 64th Annual Livestock Insect Workers Conference June 14-17, 2020 in Dallas Texas

LIWC 2020 has been canceled due to closures and travel restrictions associated with the ongoing pandemic.

The 2021 meeting will be held in Kerrville, Texas.

The 2022 meeting will be held in Dallas, Texas.

Contributions/Requests from Scientists:

From: Claire Garros, Cirad, Montpellier, FRANCE

Colleagues,

We have been very happy to see the pictures, submitted by Richard Lane, which appeared in the December, 2019 issue of the CIE newsletter. Jean-Claude Delécolle would like to share some updates [**see below** – Ed] for the first picture taken at the 1st International Ceratopogonidae meeting held in Strasbourg, France, 1974.

3: Francis Schaffner

9: Mohammad Taher Ismail

11: Philippe Arnold

14: Jocelyn Waller

15: André Razolohery (there is a typo in the family name, should be written with a h)

17: Martine Dussaucy (who married Bernard Molet)

18: still unknown



1st International Ceratopogonid meeting, Strasbourg, France, 1974 - 1 Amelia Pucat (Canada); 2 Jason Glick (US/Kenya); 3 Francis Schaffner; 4 John Boorman; 5 Michel Cornet; 6 Jean-Pierre Rieb; 7 Bill Grogan; 8 Ryzard Szadziewski; 9 Mohammad Taher Ismail; Jean Clastrier; 11 Philippe Arnold; 12 Peter Havelka; 13 E Chaker; 14 Jocelyn Waller; 15 André Razolohery; 16 Claudine Rebholtz; 17 Martine Dussaucy; 18 ?; 19 Jean Callot.

[Additionally, Claire shared the photo and identities below from Jean-Claude Delécolle. It was also taken at the 1st International Ceratopogonidae meeting in Strasbourg, France in 1974 – Ed].



Top row: left to right, J.-C. Delecolle, J. Clastrier, J. Boorman, M. Kremer, B. Molet; Middle row: A. Neveu, C. Hirtzel, P. Havelka, M. Cornet; Bottom row: J. Callot and W.W. Wirth

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From Gregg Hunt, Beaufort County Mosquito Control, Beaufort, South Carolina, U.S.A.:

The Ceratopogonidae researcher in the 3rd image that appeared in the December, 2019 issue CIE Newsletter is Dr. Wayne Rowley (former medical entomologist at Iowa State University, Ames, IA and now retired). He served as my major professor from 1976 to 1978. From 1984 to 2003, I served as a support entomologist under Dr. Walter Tabachnick (USDA Arthropod-borne Animal Diseases Research Laboratory, University of Wyoming, Laramie, WY) and worked with Bob Jones, Fred Holbrook, David Akey, Ed Schmidtman, Wayne Kramer, and others, and few times with visiting Bill Grogan.

I appreciate the vintage photos!

Gregg J. Hunt
ghunt@bcgov.net



1st International Ceratopogonid meeting, Strasbourg, France. 1974 - American ceratopogonid worker **Wayne Rowley** with his wife and Michel Kremer (right).

**From: William L. Grogan, Jr., Research Associate, Florida State Collection of Arthropods,
Gainesville, Florida, U.S.A.**

Colleagues,

I recently received a [2017 monograph by Neuhaus et al.](#) from our colleague Patrycja Dominiak. I had not previously seen it but it is extremely thorough and cites Wirth & Marston's (1968) classic phenol-ethanol and Canada balsam methods that I have used since 1973 except for a few pinned *Palpomyia* holotypes that cleared in a NaOH solution when I was just beginning work on my MS degree at the Univ. of Maryland. [This article is cited with a link to the PDF in this issue – Ed]

Best wishes,

Bill

william.grogan@fdacs.gov

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Recent Literature:

Taxonomy and Morphology

- Borkent, A. 2020.** Shrinking biodiversity, dwindling taxonomy and building a broader science. [*Megataxa* 1\(1\):53-58.](#)
- Cazorla, C.G. and F. Díaz. 2020.** *Schizonyxhelea thomsenae* (Wirth), description of the pupa and first records from Argentina, Brazil and Peru (Diptera: Ceratopogonidae). [*Anais da Academia Brasileira de Ciencias* 92\(1\):1-9.](#)
- Estrada, R. Delacour, S., Navarro, J. and J. Lucientes. 2019.** Second Iberian record of *Culicoides* (*Pontoculicoides*) *tauricus* Gutsevich, 1959 (Diptera, Ceratopogonidae), new to Granada province (Andalusia, Spain). *Boletín de la SEA* [[Published Abstract, pg. 16](#)].
- Hakima, B., H.S. Hwang, and K.Y. Lee. 2020.** Molecular identification of *Culicoides* (Diptera: Ceratopogonidae) species in Algeria. *Acta Tropica* 202: 105261 [[Read Abstract](#)].
- Jiang, X.-H., Chang, Q.-Q. and X.-H. 2019.** A morphological investigation of adult *Culicoides newsteadi* Austen (Diptera, Ceratopogonidae) using light microscopy and scanning electron microscopy. [*Acta Entomologica Sinica* 62\(9\):1090-1101.](#)
- Li, C., G. Bellis, X. Wu, and J. Li. 2019.** A new species of *Nilobezzia* Kieffer (Diptera, Ceratopogonidae) from the mangrove forest of Hainan Island, China. [*Zookeys* 893: 135-141.](#)
- Santarém, M.C.A., Borkent, A. and M.L. Felipe-Bauer. 2020.** Taxonomic Revision of Neotropical *Downshelea* Wirth and Grogan Predaceous Midges (Diptera: Ceratopogonidae). [*Insects* 11\(1\):1-94.](#) [18 new species – Ed].
- Szadziewski, R., Dominiak, P. and P. Withers. 2020.** Two New Species of Biting Midges from France and Algeria (Diptera: Ceratopogonidae). *Annales Zoologici* 70(1):113-120. [[Read Abstract](#)].
- Szadziewski, R., Sontag, E., Krzemiński, W. and J. Szwedo. 2019.** Two new genera of insectivorous biting midges (Diptera: Ceratopogonidae) from mid-Cretaceous Burmese amber. *Palaeoentomology* 2(6):657-664 [[Read Abstract](#)].

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Ecology and Methodology

- Boudot, J.-P., Havelka, P. and A. Martens. 2019.** The biting midge *Forcipomyia paludis* as a parasite of Odonata in North Africa (Diptera: Ceratopogonidae). [*Notulae Odonatologicae* 9\(4\):164-168.](#)
- England, M.E., Pearce-Kelly, P., Brugman, V.A., King, S., Gubbins, S., Sach, F., Sanders, C.J., Masters, N.J., Denison, E. and S. Carpenter. 2020.** *Culicoides* species composition and molecular identification of host blood meals at two zoos in the UK. [*Parasites & Vectors* 13:139:1-13.](#)
- Erram, D. and N. Burkett-Cadena. 2020.** Laboratory Rearing of *Culicoides stellifer* (Diptera: Ceratopogonidae), a Suspected Vector of Orbiviruses in the United States. *Journal of Medical Entomology* 57(1):25-32 [[Read Abstract](#)].
- Harsha, R., Mazumdar, S.M. and A. Mazumdar. 2020.** Abundance, diversity and temporal activity of adult *Culicoides* spp. associated with cattle in West Bengal, India. *Medical and Veterinary Entomology* [[Early View](#)].
- Jiang, X.-H., Chang, Q.-Q. and X.-H. 2019.** A morphological investigation of adult *Culicoides newsteadi* Austen (Diptera, Ceratopogonidae) using light microscopy and scanning electron microscopy. [*Acta Entomologica Sinica* 62\(9\):1090-1101.](#)
- Neuhaus, B., Schmid, T. and J. Riedel. 2017.** Collection management and study of microscope slides: Storage, profiling, deterioration, restoration procedures, and general recommendations. [*Zootaxa* 4322\(1\):1-173](#) [Monograph].
- Scharf, B., Havelka, P., Bak, M., Berggren, H., Björk, S. and C. Meisch. 2019.** Habitat characteristics, diatoms (Bacillariophyta), ceratopogonid flies (Insecta, Diptera) and ostracods (Crustacea) from freshwater rock pools at Kjugekull, southern Sweden. [*Bulletin de la Societe des Naturalistes Luxembourgeois* 121: 265-275.](#) [*Dasyhelea bilineata* larvae were abundant in some rock pools – Ed].
- Seehausen, M., Kunz, B., Havelka, P. and A. Martens. 2019.** An ectoparasite of caterpillars, *Forcipomyia fuliginosa* (Diptera: Ceratopogonidae), recorded sucking haemolymph from an *Aeshna juncea* just before maiden flight (Odonata: Aeshnidae). [*Notulae Odonatologicae* 9\(4\):169-172.](#)
- Shih, C.-L., Lao, Q.-M., Wang, Y.-Y. and W.-C. Tu. 2019.** Abundance and host-seeking activity of the biting midge, *Forcipomyia taiwana* (Diptera: Ceratopogonidae). *Journal of Asia Pacific Entomology* 22(4):1053-1059 [[Read Abstract](#)].

- Tomazatos, A., Jöst, H., Schulz, J., Spinu, M., Schmidt-Chanasit, J., Cadar, D. and R. Lühken. 2020.** Blood-meal analysis of *Culicoides* (Diptera: Ceratopogonidae) reveals a broad host range and new species records for Romania. [*Parasites & Vectors* 13:79:1-12.](#)
- Wang, S.-C., Ching, Y.-H., Krishnaraj, P., Chen, G.-Y., Rhadnakrishnan, A. S., Lee, H.-M., Tu, W.-C. and M.-D. Lin. 2020.** Oogenesis of Hematophagous Midge *Forcipomyia taiwana* (Diptera: Ceratopogonidae) and Nuage Localization of Vasa in Germline Cells. [*Insects* 11\(2\):106:1-15.](#)
- Wildermuth, H., Schroter, A. and S. Kohl. 2019.** The West Palearctic biting midge *Forcipomyia paludis* (Diptera: Ceratopogonidae): first evidence as a parasite on Odonata wings from the Caucasus ecoregion. [*Notulae Odonatologicae* 9\(4\).](#)

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Bluetongue Virus and Other Pathogens

- Bah, Y. M., Sonnie, M., Conteh, A., Sawyerr, V., Konneh, A., Veinoglou, A., Hodgres, M. and Y. Zhang. 2019.** *Mansonella perstans* in Lymphatic Filariasis Hotspots in Sierra Leone. *American Journal of Tropical Medicine and Hygiene* 101(5):Supplement [[Published Abstract 182, pg. 393](#)].
- Becker, M.E., S. Healy, W. Forbes, J. Roberts, J. LaCour, and L.D. Foil. 2020.** Postmortem Detection of Bluetongue and Epizootic Hemorrhagic Disease Viruses in the Bone Marrow of White-Tailed Deer (*Odocoileus virginianus*). *Journal of Wildlife Diseases* 56(1): 58-65 [[Read Abstract](#)].
- Bukauskaitė, D., Chagas, C.R.F., Bernoitienė, R., Žiegytė, R., Ilgūnas, M., Iezhova, T. and G. Valkiūnas. 2019.** A new methodology for sporogony research of avian haemoproteids in laboratory-reared *Culicoides* spp., with a description of the complete sporogonic development of *Haemoproteus pastoris*. [*Parasites & Vectors* 12\(582\):1-14.](#)
- Bumbarov, V., N. Golender, M. Jenckel, K. Wernike, M. Beer, E. Khinich, O. Zalesky, and O. Erster. 2020.** Characterization of bluetongue virus serotype 28. [*Transboundary and Emerging Diseases* 67: 171-182.](#)

- Chanmol, W., Jariyapan, N., Somboon, P., Bates, M.D., and P.A. Bates. 2019.** Development of *Leishmania orientalis* in the sand fly *Lutzomyia longipalpis* (Diptera: Psychodidae) and the biting midge *Culicoides soronensis* (Diptera: Ceratopogonidae). *Acta Tropica* 199:105157 [[Read Abstract](#)].
- Charon, J., M.J. Grigg, J.S. Eden, K.A. Piera, H. Rana, T. William, K. Rose, M.P. Davenport, N.M. Anstey, and E.C. Holmes. 2019.** Novel RNA viruses associated with *Plasmodium vivax* in human malaria and *Leucocytozoon* parasites in avian disease. *PLoS Pathogens* 15(12): e1008216.
- Cohen, P.R. 2019.** Acquired Asymptomatic Blue Tongue: A Report of Exogenous Agent-associated Tongue Dyschromia and Review of Blue Tongue Etiologies. *Cureus* 11(11): e6243.
- Coulibaly, Y.I., Dolo, H., Fayinke, T., Diabate, A.F., Coulibaly, S.Y., Sangare, M.B., Soumaoro, L., Coulibaly, M.E., Doumbia, S.S., Diallo, A.A., Dembele, B., Sanogo, D., Konate, S., Traore, S.F. and A.D. Keita. 2019.** Long-Term Impact of Albendazole Plus Ivermectine Double Dose, Twice-Yearly on the Suppression of *Mansonella perstans* Microfilarial Load. *American Journal of Tropical Medicine and Hygiene* 101(5): Supplement [[Published Abstract 1149, pg. 353](#)].
- Coulibaly, Y. I., Soumaoro, L., Dembele, B., Hodges, M. and Y. Zhang. 2019.** Potential Cross Reactivity of *Mansonella perstans* with *Wuchereria bancrofti* by Filariasis Test Strips. *American Journal of Tropical Medicine and Hygiene* 101(5): Supplement [[Published Abstract 523, pg. 161](#)].
- De Nardi, M., Léger, A., Adkin, A., Ru, G. and K.D.C. Stärke. 2019.** Description of surveillance components related to classical swine fever, blue tongue and rabies in selected European countries: An experts' knowledge elicitation. *Microbial Risk Analysis* 13: 100081. [[Read Abstract](#)].
- Dinh, E.T.N., Cauvin, A., Orange, J.P., Shuman, R.M., Wisely, S.M. and J. K. Blackburn. 2020.** Living la Vida T-LoCoH: site fidelity of Florida ranched and wild white-tailed deer (*Odocoileus virginianus*) during the epizootic hemorrhagic disease virus (EHDV) transmission period. *Movement Ecology* 8:14:1-9.
- do Nascimento, V.A., Santos, J.H.A., da Silva Montiero, D.C., Pessoa, K.P., Leao Cardoso, A.J., de Souza, V.C., Abdalla, L.F. and F.G. Naveca. 2020.** Oropouche virus detection in saliva and urine. *Memorias do Instituto Oswaldo Cruz* 115:e190338.

- Duran-Ferrer, M., Agüero, Zeintara, S., Beck, C., Lecollinete, Sailleau, C., Smith, S., Potgieter, C., Reuda, P., Sastre, P., Monaco, F., Villalba, R., Tena-Tomas, C., Batten, C., Frost, L., Flannery, J., Gubbins, S., Lubisi, B.A., Sanchez-Vizcaino, J.M., Emery, M., Sturgill, T., Ostlund, E. and J. Castillo-Olivares. 2019. Assessment of reproducibility of a VP7 Blocking ELISA diagnostic test for African horse sickness. [*Transboundary and Emerging Diseases* 66:83-90.](#)
- Erram, D. B.-C. N. 2020. Laboratory Rearing of *Culicoides stellifer* (Diptera: Ceratopogonidae), a Suspected Vector of Orbiviruses in the United States. *Journal of Medical Entomology* 57(1):25-32 [[Read Abstract](#)].
- Fecchio, A., J.A. Bell, M. Bosholn, J.A. Vaughan, V.V. Tkach, H.L. Lutz, V.R. Cueto, C.A. Gorosito, D. Gonzalez-Acuna, C. Stromlund, D. Kvasager, K.J.M. Comiche, K. Kirchgatter, J.B. Pinho, J. Berv, M. Anciaes, C.S. Fontana, K. Zyskowski, S. Sampaio, J.H. Dispoto, S.C. Galen, J.D. Weckstein, and N.J. Clark. 2020. An inverse latitudinal gradient in infection probability and phylogenetic diversity for *Leucocytozoon* blood parasites in New World birds. *Journal of Animal Ecology* 89(2): 423-435 [[Read Abstract](#)].
- Fonseca, L., R.H. Carvalho, A.C. Bandeira, S.I. Sardi, and G.S. Campos. 2020. Oropouche Virus Detection in Febrile Patients' Saliva and Urine Samples in Salvador, Bahia, Brazil. [*Japanese Journal of Infectious Diseases* 73: 164-165.](#)
- Gomez, D.E., Egurrola, J.A., Cruz, C., Ochoa, M., Guevara, C., Silva, M. and J.S. Ampuera. 2019. First Report of the Oropouche Virus in Colombia. *American Journal of Tropical Medicine and Hygiene* 101(5):Supplement [[Published Abstract 1529, pg. 470](#)].
- Gutierrez, B., Wise, E.L., Pullan, S.T., Logue, C.H., Bowden, T.A., Escalero-Zamudio, M., Trueba, G., Nunes, M.R.T., Faria, N.R. and O. Pybus. 2020. Evolutionary Dynamics of Oropouche Virus in South America. *Journal of Virology* [[online 4 Dec 2019](#)].
- Haegeman, A., L. Vandaele, I. De Leeuw, A.P. Oliveira, H. Nauwynck, A. Van Soom, and K. De Clercq. 2019. Failure to Remove Bluetongue Serotype 8 Virus (BTV-8) from in vitro Produced and in vivo Derived Bovine Embryos and Subsequent Transmission of BTV-8 to Recipient Cows After Embryo Transfer. [*Frontiers in Veterinary Science* 6: 432:1-9.](#)
- Li, Z., Sinha, A., Poole, C.B., Morgan, R.D., Ettwiller, L., Lima, N.F., Ferrera, M.U., Wanji, S. and C.K. Carlow. 2019. Genome Sequences of the *Wolbachia* Endosymbionts from the Filarial Parasites *Mansonella perstans* and *Mansonella ozzardi*. *American Journal of Tropical Medicine and Hygiene* 101(5): Supplement [[Abstract 519, pg. 160](#)].

- Luciani, M., di Febo, T., Ronchi, G.F., Sacchini, F., Rossi, E., Ulisse, S., D, Pancrazio, C., Antonucci, D., Salini, R., Teodori, L., Vulpiani, M.P., Tittarelli, M. and M. Di Ventura. 2020.** Alternative methods to reduce the animal use in quality controls of inactivated BTV8 Bluetongue vaccines. *Preventive Veterinary Medicine* 176:104923. [[Read Abstract](#)].
- Ma, J., Gao, X., Liu, B., Xiao, J., Chen, H. and H. Wang. 2019.** Spatial Patterns and Risk Factors of Bluetongue Virus Infection in Inner Mongolia, China. *Vector Borne and Zoonotic Diseases* 19(7) [[Read Abstract](#)].
- Marin-Lopez, A., N. Barreiro-Pineiro, S. Utrilla-Trigo, D. Barriales, J. Benavente, A. Nogales, J. Martinez-Costas, J. Ortego, and E. Calvo-Pinilla. 2020.** Cross-protective immune responses against African horse sickness virus after vaccination with protein NS1 delivered by avian reovirus muNS microspheres and modified vaccinia virus Ankara. *Vaccine* 38: 882-889 [[Read Abstract](#)].
- Mohanty, N.N., S.B. Shivachandra, S.K. Biswas, V. Nagaraj, T.J. Basheer, D. Narendra Babu, R. Yogisharadhya, and D. Hemadri. 2019.** An efficient production of hybrid recombinant protein comprising non-structural proteins (NS 1 & NS 3) of bluetongue virus in prokaryotic expression system. *Protein Expression and Purification* 55:15-20. [[Read Abstract](#)].
- Mokoena, N.B., Moetlhoa, B., Rutkowska, D.A., Mamputha, S., Dibakwane, V.S., Tsekoe, T.L. and M.M. O’Kennedy. 2019.** Plant-produced Bluetongue chimaeric VLP vaccine candidates elicit serotype-specific immunity in sheep. *Vaccine* 37(41):6068-6075 [[Read Abstract](#)].
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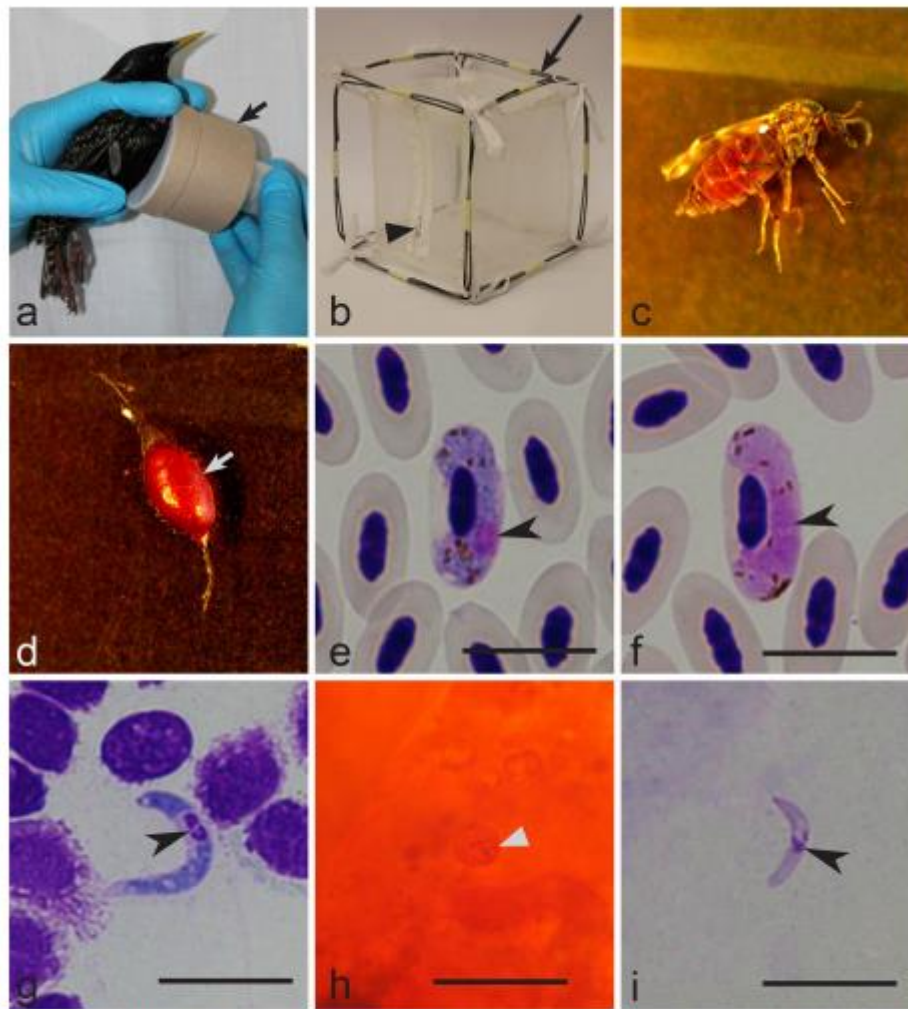
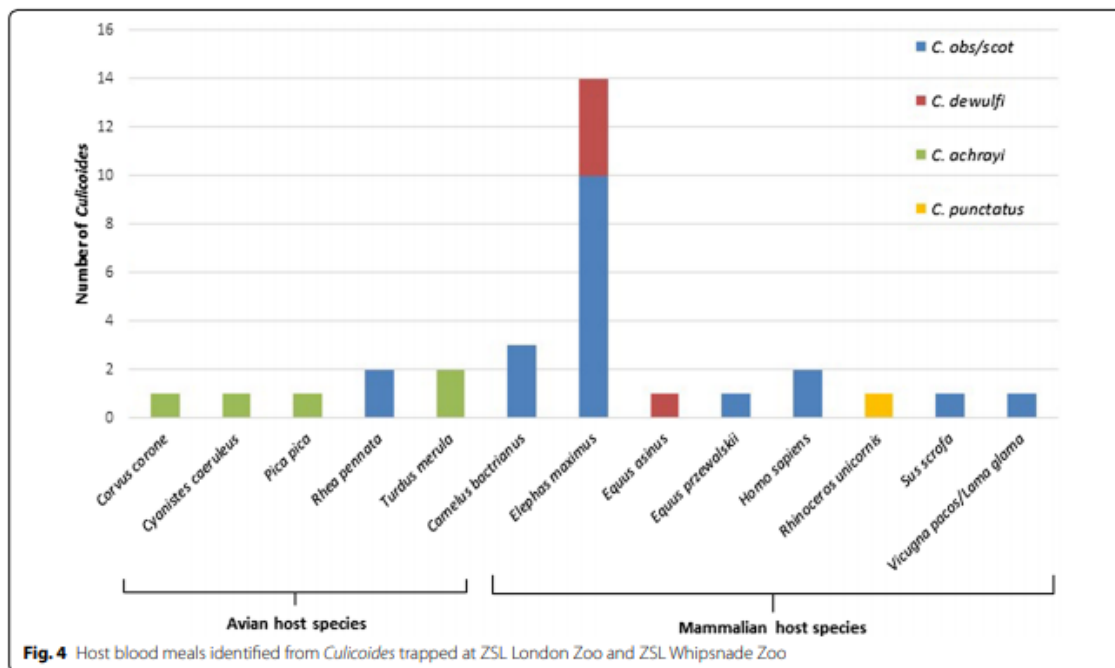


Fig. 3 Main procedures of exposure of *Culicoides nubeculosus* colony to *Haemaphysalis pastorei* (lineage hLAMPUR01) infection by allowing the insects to take blood meal on naturally infected common starling *Sturnus vulgaris* (a, b). Note that exposure was done by gentle touching of a cardboard box (arrow) with biting midges to the pectoral muscle of the infected bird (a) and then engorged insects are released into a larger insect cage (b) (note that a zipper is sewed into one side of the cage) long arrow, insect cage; triangle arrowhead, zipper. Exposed females (c) were maintained in insect cage made of bolting silk (b) and their midguts were dissected (d) (arrow, dissected midgut full with blood). Mature gametocytes (e, f) were present in the peripheral blood of the infected starling (arrowheads, parasite nuclei), and the sporogonic stages (g-i) developed in exposed female biting midges: macrogametocyte (e); microgametocyte (f); ookinete (g) (arrowhead, parasite nuclei); oocyst (h) (arrowhead, oocyst); sporozoite (i) (arrowhead, parasite nuclei). Giemsa (e-g, i) and mercurochrome (h) stained preparations. Scale-bars: 10 μ m

From: [Bukauskaitė et al. 2019](#)



From: [England et al. 2020](#)

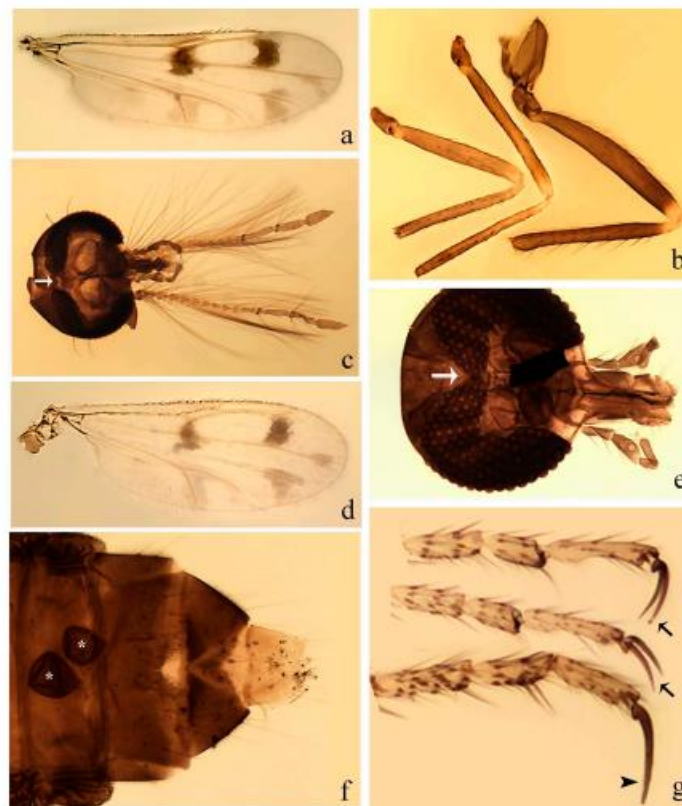


Figure 11. *Downesiolela carioca*, male: (a) wing; (b) fore-, mid-, hind legs (left to right), lateral view; (c) head, anterior view; arrow: eyes separation. Female: (d) wing; (e) head, anterior view; arrow: eyes separation; (f) apex of abdomen, ventral view; asterisks: spermathecae; (g) arrow: fore-, mid legs claws; arrowhead: hind legs claw (top to bottom), lateral view.

From: [Santarém et al. 2020](#)



Fig. 2. *Forcipomoma fuliginosa* sucking at a freshly emerged *Aeshna juncea* in dorsal view. Nadibani, Mtskheta-Mtianeti, Georgia (29-vi-2014). Photo: MS

From: [Seehausen et al. 2019](#)

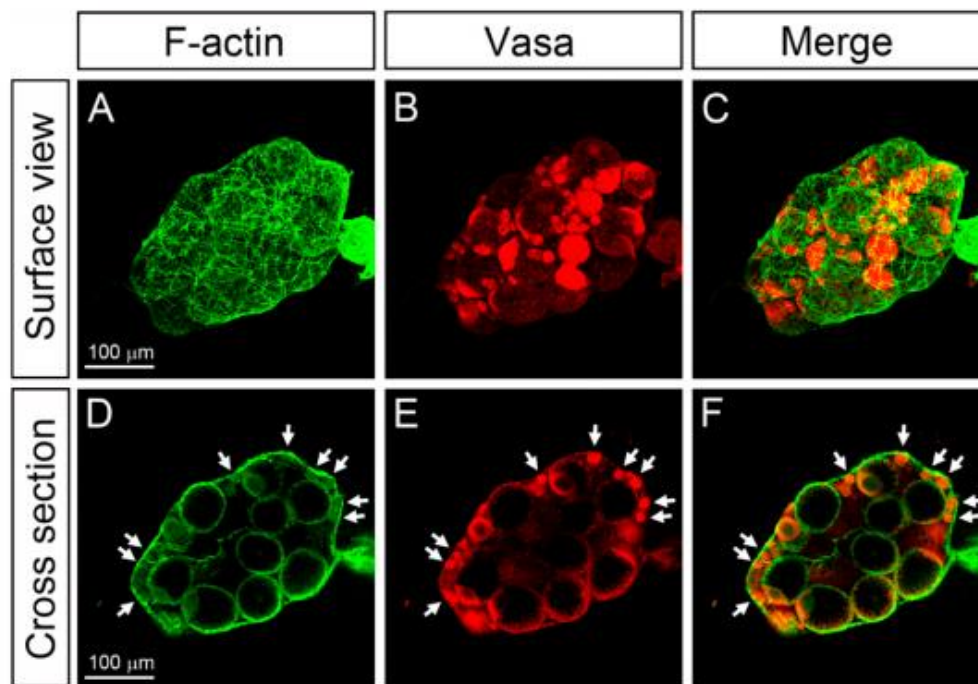


Figure 3. The ovarian structure and the alignment of ovarioles within the ovary of *F. taiwana*. (A–F) Confocal micrographs showing the ovarian structure of *F. taiwana* at 15 h post-blood meal. The F-actin was revealed by phalloidin staining (green), whereas the germline cells were marked by polyclonal rabbit anti-Vasa antibody (red). (A–C) The surface view revealed the F-actin enriched ovarian sheath (A) and germ line cells (B). (C) Merged image. (D–F) The optical cross-section showed that the germarium of each ovariole (arrows in E) was bound to the ovarian sheath (arrows in D). (E) Merged image.

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