

**Table S1:** Sample studies reporting the presence of antibiotic resistant bacteria in insects

Insect	Sampling site	Antibiotics/Antibiotic class	Antibiotic Resistance Genes	Organism	Methods	Country	Reference
Mealworm, Crickets	Rearing company	Tetracyclines, Macrolides	tet(O, K, M, S), erm(B)	NA	Real-time PCR	Belgium and Netherlands	(Vandeweyer et al., 2019)
locusts, mealworm giant waterbugs, black ants, winged termite alates, rhino beetles, mole crickets, silkworm, and black scorpions	Retailers	Macrolides; $\beta$ -lactams	Erm(B, C), tet(O, K, M, S), blaZ	NA	PCR	Netherlands and Thailand	(Milanović et al., 2016)
Small crickets ( <i>Acheta domesticus</i> )	Retailers	tetracyclines, macrolide-lincosamide-streptogramin B (MLS <sub>B</sub> ), beta-lactams, and aminoglycosides	tet(M), tet(O), tet(K), tet(S), erm(B), erm(C), blaZ and mecA, aac(6')-Ie aph(2'')-Ia	NA	PCR	Italy	(Roncolini et al., 2019)

Cockroach	Hospital environment	Penicillins, Cephems, Aminoglycosides, macrolides. Folate inhibitors, Tetracyclines, fluoroquinolones, Lincosamides, Phenicol, Ansamycins	blaZ, aacA-D, tetK, msrA, dfrA, mcrA, vatB, tetM, grlA, rpoB, vatA, linA, ermA, cat1	<i>Staphylococcus aureus</i>	Culture, PCR	Iran	(Abdolmaleki et al., 2019)
Cockroaches	Household kitchens	ampicillin, cephalothin, ceftriaxone, ciprofloxacin, chloramphenicol, gentamicin, tetracycline, trimethoprim-sulfamethoxazole, ceftazidime, amikacin, nitrofurantoin, nalidixic acid, cefalexin, cefotaxime, kanamycin, penicillin	NA	Enterobacter spp., Klebsiella spp., Citrobacter spp., E. coli, Salmonella spp., Proteus spp., coagulase negative staphylococci, S. marcescens, Staphylococcus aureus, and Bacillus species	Culture	Iran	(Vazirianzadeh et al., 2014)
Honeybee	Bee farm	Streptomycin	strA-strB	NA	Sequencing	Norway, USA	(Ludvigsen et al., 2018)

Mosquitoes	Field adult and reared larvae	beta-lactamase, Fluoroquinolones, aminoglycosides	IMI, NMC-A, OXA-18, OXA-58 Group, QnrD, OXA-60, SHV(156G), aadA1	N/A	Sequencing	USA	(Hyde et al., 2019)
House flies; cockroach	Pig farm	Tetracyclines, macrolides	tet(M), tet(O), tet(K), tet(S), erm(B)	Enterococcus spp	Culture; PCR	USA	(Ahmad et al., 2011)
True Flies	Hospital in urban areas	Penicillins, carbapenems, aminoglycosides, fluoroquinolones, quinolones, tetracyclines, phenicol, Lipopeptides, glycopeptides, Macrolides	NA	Multiple Micrococcus sp., Aerococcus sp., Enterococcus spp., Streptococcus spp., Staphylococcus spp., Bacillus spp., Citrobacter spp. Klebsiella spp.  Leclercia spp., Pantoea spp., Enterobacter spp., Raoultella spp., Escherichia spp.	Culture	UK	(Matilla et al., 2018)

Cockroach	Households	Ampicillin, gentamicin, ciprofloxacin, ofloxacin, chloramphenicol, tetracycline, sulfamethoxazole/trimethoprim, penicillin, streptomycin, erythromycin, oxacillin, vancomycin, cephalothin, ceftazidime, imipenem, piperacillin, and cefoperazone	NA	Staphylococcus aureus, Enterococcus species, Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, Serratia marcescens, and Proteus species	Culture	Taiwan	(Pai et al., 2005)
Grasshopper			Erm (B, C), tet(K, M, S), blaZ, aac(6')-Ie aph(2'')		Culture, PCR	Netherlands and Thailand	(Osimani et al., 2017)
Flies	Cattle farm	amoxicillin/clavulanic acid; ampicillin; cefoxitin; ceftriaxone; chloramphenicol; nalidixic acid; sulfisoxazole; streptomycin; tetracycline; trimethoprim.	NA		Culture	USA	(Xu et al., 2018)

Flies	Dairy farms	Ampicillin, Cephalexin, Ceftriaxone, Ciprofloxacin, Enrofloxacin, Gentamicin, Oxacillin, Penicillin G, Sulphazotrin, Tetracycline		<i>Escherichia coli</i> , <i>Salmonella</i> spp., <i>Staphylococcus</i> spp.		Brazil	(Almeida et al., 2014)
Flies	markets, hospitals, houses/human habitations, pit latrines, stalls of local food vendors, abattoirs/slaught erhouses, and dairy farms	(tetracyclin, erythrocycline and cloxacillin) (penicillin-G and erythromycin); (streptomycin, ampicillin); (cloxacillin clindamycin) tetracycline,	NA	<i>Streptococcus</i> spp.; <i>E. coli</i> ; <i>Serratia</i> spp. <i>Proteus</i> spp.; <i>Klebsiella</i> spp.	Culture	Nigeria	(Nmorsi et al., 2007)

Flies	Dairy farm	ampicillin; amoxicillin/clavulanic acid; cefalexin; ceftriaxone; cefoperazone; ceftiofur; ciprofloxacin; enrofloxacin; chloramphenicol; sulfamethoxazole/trimethoprim; gentamicin; tetracycline.	blaCTX-M, blaTEM, tetA, (int1-dfrA7-attC-qacEΔ1), dfrA7	<i>E. coli</i>	Culture + PCR	Brazil	(Alves et al., 2018)
Cockroach	Household	gentamicin; tigecycline; ciprofloxacin; cotrimoxazole; cefoxitin; cefuroxime; cefotaxime; ampicillin; augmentin; chloramphenicol; tetracycline; nitrofurantoin; aztreonam; amoxicillin/clavulanic acid, piperacillin/tazobactam; ceftaroline	blaTEM-24, blaTEM-14, blaCTX-M-15/TEM-4, blaCTX-M-15/TEM-1, blaSHV-3, TEM-1, OXA-48	<i>E. coli</i>	Culture, PCR	Ghana	(Obeng-Nkrumah et al., 2018)

Mosquitoes	Residential	Doripenem, piperacillin, cefuroxime, erythromycin, ampicillin		<i>Staphylococcus hominis, Escherichia coli, Pantoea agglomerans, Acinetobacter pittii,</i>	Culture, MALDI TOF	Slovakia	(Hleba et al., 2017)
Blowflies and Houseflies	Farms and urban areas	Beta-lactams	<i>CTX-M, TEM, SHV, qnrS, LAB</i>	<i>E. coli</i>	Culture, PCR, Sequencing	Germany	(Wetzker et al., 2019)
Houseflies	Urban, semi-urban and rural residential areas	Clindamycin, tetracycline, penicillin, oxacillin, rifampicin, fusidic acid, trimethoprim/sulfa methoxazole, ceftriaxone, ceftazidime, aztreonam, ciprofloxacin, trimethoprim-sulfamethoxazole.	<i>blaCTX-M, blaTEM</i>	<i>Bacillus cereus, Enterococcus faecalis, Enterococcus faecium, Clostridioides tertium, Bacillus licheniformis, Bacillus subtilis, Enterococcus hirae, S. aureus positive</i>	Culture, Whole-genome sequencing	Nigeria	(Onwugamba et al., 2020)

Cockroach	Hospital, human dwelling, restaurant	Chloramphenicol, Amoxicillin, Streptomycin, Tetracycline, Erythromycin, Gentamicin, Penicillin, Cephalothin, Sulfamethoxazole, Ciprofloxacin, Levofloxacin	NA	<i>Salmonella</i> spp; <i>Shigella</i> spp; <i>Escherichia coli</i> ; CON <i>Staphylococcus</i> spp; <i>Bacillus cereus</i> ; <i>Staphylococcus aureus</i> ; <i>Pseudomonas aeruginosa</i> ; <i>Klebsiella pneumoniae</i> ; <i>Citrobacter freundii</i> ; <i>Morganella morganii</i> ; <i>Proteus vulgaris</i> ; <i>Proteus mirabilis</i> ; <i>Enterobacter cloacae</i> ; <i>Providencia</i> spp.	Culture	Nigeria	(Akinjogunlaa et al., 2012)
Butterfly	Forest and densely populated human residential area	erythromycin; ciprofloxacin; norfloxacin; rifampicin.	None	<i>Enterococci</i>	Culture, PCR, sequencing	Brazil	(Huff et al., 2020)



Houseflies	Hospital, farm, food centre, city centre	Ampicillin; Chloramphenicol; Ciprofloxacin; Colistin; Erythromycin; Gentamicin; Imipenem; Meropenem; Streptomycin; Tetracycline.	<i>CTX-M, catA1, mcr-3, ereA</i>  <i>tetA, tetB, SHV</i>	<i>E. coli</i>	Culture, PCR	Bangladesh	(Sobur et al., 2019)
Cockroaches	Households and restaurants	Aminoglycosides, Macrolides, Cephems, Lincosamides, Penicillins	NA	<i>Staphylococcus aureus</i>	Culture	Bangladesh	(Islam et al., 2016)
Flies	Hospital and surrounding residential suburban areas	Beta-lactams	<i>CTX-M-1, TEM, SHV, CTX-M-9, CTX-M-2</i>	<i>Raoultella spp., Kluyvera spp., Enterobacter spp., Escherichia coli, Citrobacter spp., Klebsiella spp., Providencia spp., Proteus spp.,</i>	Culture, PCR	Ethiopia	(Tufa et al., 2020)

				<i>Moellerella wisconsensis</i>			
Cockroaches	Hospital and households	gentamycin; cotrimoxazole; tetracycline; chloramphenicol; amoxicillin-clavulanic acid; ciprofloxacin; nalidixic acid; ceftriaxone; ceftazidime; penicillin; erythromycin.	NA	<i>S. aureus; coagulase negative staphylococci; E. coli, Enterobacter species, Klebsiella spp.</i>	Culture	Ethiopia	(Moges et al., 2016)

Houseflies	Hospital, streets, abattoir	Amoxicillin Amoxicillin-clavulanic acid Cephaloridine Ceftriaxone Chloramphenicol Amikacin Kanamycin, Norfloxacin, Nalidixic, Doxycycline, Trimethoprim-sulphamethoxazole	NA	<i>Escherichia coli</i> <i>Salmonella</i> sp. <i>Shigella sonnei</i> <i>Yersinia enterocolitica</i> <i>Edwardsiella tarda</i> <i>Klebsiella</i> sp. <i>Enterobacter</i> sp. <i>Citrobacter</i> sp. <i>Proteus</i> sp. <i>Providencia</i> sp. <i>Serratia</i> sp. <i>Erwinia</i> sp. <i>Aeromonas</i> sp. <i>Flavobacterium</i> sp. <i>Pseudomonas</i> sp. <i>Xanthomonas</i> sp. <i>Weeksella zoohleum</i> <i>Pasteurella</i> sp. <i>Staphylococcus</i> sp. <i>Streptococcus</i> sp.	Culture	Libya	(Rahuma et al., 2005)
------------	-----------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------	-------	-----------------------

Cockroach	Restaurants and cafeteria	Norfloxacin, Oxacillin, Vancomycin, Penicillin G, Clindamycin, Erythromycin, Tetracycline, Ciprofloxacin, Chloramphenicol, Cephalothin, Streptomycin	NA	S. aureus, B. cerus, Salmonella spp., Shigella flexneri, E. coli	Culture	Ethiopia	(Solomon et al., 2018)
-----------	---------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----	---------------------------------------------------------------------------	---------	----------	---------------------------

Cockroaches and houseflies	Human residences	ampicillin; amoxicillin-clavulanate; piperacillin-tazobactam; cefoxitin; ceftazidime; cefepime; imipenem; ertapenem; meropenem; gentamicin; amikacin; cotrimoxazole; ciprofloxacin	NA	Acinetobacter lwoffii, Alcaligenes spp., Citrobacter spp., Enterobacter spp., Escherichia coli, Klebsiella spp. Leclercia Adecarboxylata, Moellerella Wisconsensis, Morganella morganii, Pasteurella spp., Proteus spp., Providencia spp., Salmonella spp., Serratia spp., Shigella dysenteriae, Yersinia enterocolitica, Staphylococcus aureus, Staphylococcus coagulase-negative Enterococcus spp.	Culture	Morocco	(Bouamama et al., 2010)
----------------------------	------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------	---------	-------------------------

Cockroaches	Hospital	NA	NA	ESBL-Producing K. pneumoniae, Escherichia coli, Serratia marcescens, Enterobacter cloacae, Citrobacter freundii, Acinetobacter baumannii and Enterococcus spp	Culture	South Africa	(Cotton et al., 2000)
Cockroach	Households and restaurants	Ampicillin, piperacillin, cephalothin, chloramphenicol, tetracycline, sulfamethoxazole/t rimethoprim, ceftazidime, gentamicin.	NA	<i>Pseudomonas aeruginosa</i> , <i>Klebsiella pneumonia</i> , <i>Escherichia coli</i> , <i>Citrobacter freundii</i> , <i>Enterobacter aerogenes</i> , <i>Proteus mirabilis</i>	Culture	India	(Leshan Wannigama et al., 2013)
Fly	Restaurants and farms	Amoxicillin, roxithromycin, cefaclor	NA	<i>E. coli</i> , <i>En. faecalis</i> , <i>Salmonella sp.</i> , <i>Shigella sp.</i>	Culture	Australia	(Vriesekoop and Shaw, 2010)

Flies	Airport	amoxicillin, ticarcillin, cephalothin, cefuroxime, ceftazidime, piperacillin, cefotaxime, ticarcillin- clavulanate, trimethoprim- sulfamethoxazole, ciprofloxacin, gentamicin, cefepime, tobramycin, ceftazidime, cefoxitin, amikacin, netilmicin, amoxicillin- clavulanate, piperacillin- tazobactam.	<i>bla</i> TEM, <i>bla</i> SHV <i>acc</i> (3)-II, <i>aph</i> A1 <i>aph</i> A2. <i>qnr</i> B, <i>qnr</i> S <i>aac</i> (6')- 1b.	<i>Escherichia</i> <i>Coli</i> , <i>Klebsiella</i> <i>pneumoniae</i> , <i>Pseudomonas</i> <i>aeruginosa</i> , <i>Aeromonas</i> <i>hydrophila</i>	Culture, PCR	China	(Liu et al., 2013)
-------	---------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------	-------	--------------------





				<i>Serratia fonticola</i>			
				<i>Staphylococcus capitis</i>			
				<i>Staphylococcus edaphicus</i>			
				<i>Staphylococcus warneri</i>			
				<i>Kluyvera intermedia</i>			
				<i>Staphylococcus epidermidis</i>			

Bed gugs	Hospital	Vancomycin, ampicillin, teicoplanin, aminoglycosides	NA	Vancomycin Resistant Enterococci, MRSA	Culture	Canada	(Lowe and Romney, 2011)
Flies	Hospital		Numerous genes ( <a href="https://doi.org/10.1186/s13756-020-0696-y">https://doi.org/10.1186/s13756-020-0696-y</a> .)	<i>E. coli</i> , <i>Klebsiella</i> spp., <i>Enterobacter</i> spp., <i>Aci- netobacter</i> spp., <i>P. aeruginosa</i> , <i>Citrobacter</i> spp., <i>Raoultella</i> spp.	Culture, MALDI_TOF, WGS	Rwanda	(Heiden et al., 2020)
Ants	Hospital	amoxicillin, amoxicillin- clav.acid, piperacillin, ticarcillin, ticarcillin- clav.acid, cephalothin, cefoxitin, cefotaxim, ceftazidim, cefepim, cefuroxim, ceftazidime, cotrimoxazol, tobramycin, gentamicin, netilmicin	NA	<i>S. aureus</i> , <i>A. baumannii</i> , <i>E.agglomerans</i> , <i>E. amnigenus</i> , <i>E. cloacae</i> , <i>K. oxytoca</i> , <i>K.pneumoniae</i> , <i>S. rubidae</i>	Culture, biochemical tests	Brazil	(Moreira et al., 2005)

Houseflies	Markets	Ampicillin, Sulfamethoxazole-trimethoprim, Streptomycin, Tetracycline, Gentamycin, Nalidixic acid, Ceftazidime,  Chloramphenicol, Norfloxacin,  Ciprofloxacin, Cefotaxime	<i>blaTEM</i> , <i>blaSHV</i> , <i>blaCTX-M</i>	<i>Salmonella</i> spp., Enteropathogenic <i>E. coli</i>	Culture, PCR	Zambia	(Songe et al., 2017)
Houseflies	Farms	Beta-lactams, quinolones, aminoglycosides	<i>blaCTX-M</i> , <i>blaTEM</i> , <i>qnrS</i>	ESBL-producing <i>E. coli</i> strains	Culture, PCR	Spain	(Solà-Ginés et al., 2015)

## References

- Abdolmaleki, Z., Mashak, Z., Safarpour Dehkordi, F., 2019. Phenotypic and genotypic characterization of antibiotic resistance in the methicillin-resistant *Staphylococcus aureus* strains isolated from hospital cockroaches. *Antimicrob. Resist. Infect. Control* 8, 1–14. doi:10.1186/s13756-019-0505-7
- Ahmad, A., Ghosh, A., Schal, C., Zurek, L., 2011. Insects in confined swine operations carry a large antibiotic resistant and potentially virulent enterococcal community. *BMC Microbiol.* 11, 23. doi:10.1186/1471-2180-11-23
- Akinjogunla, O.J., Odeyemib, A.T., Udoinyang, E.P., 2012. Cockroaches (*periplaneta americana* and *blattella germanica*): reservoirs of multi drug resistant (MDR) bacteria in Uyo, Akwa Ibom State. *Sci. J. Biol. Sci.* 1, 19–30.
- Almeida, J.L., Giuffrida, R., Andrade, R.A.P., Chaves, M.P., 2014. Muscoid Diptera as potential vectors of bacterial agents on dairy farms in the northern region of Paraná, Brazil. *Semin. Ciências Agrárias* 35, 3127. doi:10.5433/1679-0359.2014v35n6p3127
- Alves, T. dos S., Lara, G.H.B., Maluta, R.P., Ribeiro, M.G., Leite, D. da S., 2018. Carrier flies of multidrug-resistant *Escherichia coli* as potential dissemination agent in dairy farm environment. *Sci. Total Environ.* 633, 1345–1351. doi:10.1016/j.scitotenv.2018.03.304
- Bouamama, L., Sorlozano, A., Laglaoui, A., Lebbadi, M., Aarab, A., Gutierrez, J., 2010. Antibiotic resistance patterns of bacterial strains isolated from *Periplaneta americana* and *Musca domestica* in Tangier, Morocco. *J. Infect. Dev. Ctries.* 4, 194–201. doi:10.3855/jidc.336
- Cotton, M.F., Wasserman, E., Pieper, C.H., Theron, D.C., Van Tubbergh, D., Campbell, G., Fang, F.C., Barnes, J., 2000. Invasive disease due to extended spectrum beta-lactamase-producing *Klebsiella pneumoniae* in a neonatal unit: The possible role of cockroaches. *J. Hosp. Infect.* 44, 13–17. doi:10.1053/jhin.1999.0650
- Dunbar, J.P., Khan, N.A., Abberton, C.L., Brosnan, P., Murphy, J., Afoullouss, S., O'Flaherty, V., Dugon, M.M., Boyd, A., 2020. Synanthropic spiders, including the global invasive noble false widow *Steatoda nobilis*, are reservoirs for medically important and antibiotic resistant bacteria. *Sci. Rep.* 10, 1–11. doi:10.1038/s41598-020-77839-9
- Heiden, S.E., Kurz, M.S.E., Bohnert, J., Bayingana, C., Ndoli, J.M., Sendegeya, A., Gahutu, J.B., Eger, E., Mockenhaupt, F.P., Schaufler, K., 2020. Flies from a tertiary hospital in Rwanda carry multidrug-resistant Gram-negative pathogens including extended-spectrum beta-lactamase-producing *E. coli* sequence type 131. *Antimicrob. Resist. Infect. Control* 9, 2–5. doi:10.1186/s13756-020-0696-y
- Hleba, L., Kmeť, V., Tóth, T., Kačániová, M., 2017. Resistance in bacteria and indirect beta-lactamase detection in *E. coli* isolated from *Culex pipiens* detected by matrix-assisted laser desorption ionization time of flight mass spectrometry. *J. Environ. Sci. Heal. - Part B Pestic. Food Contam. Agric. Wastes* 52, 64–69. doi:10.1080/03601234.2016.1229466
- Huff, R., Pereira, R.I., Pissetti, C., De Araújo, A.M., D'Azevedo, P.A., Frazzon, J., Frazzon, A.P.G., 2020. Antimicrobial resistance and genetic relationships of enterococci from siblings and non-siblings *Heliconius erato phyllis* caterpillars. *PeerJ* 2020, 1–20. doi:10.7717/peerj.8647

- Hyde, J., Gorham, C., Brackney, D.E., Steven, B., 2019. Antibiotic resistant bacteria and commensal fungi are common and conserved in the mosquito microbiome. *PLoS One* 14, e0218907. doi:10.1371/journal.pone.0218907
- Islam, A., Islam, S., Nath, A.D., Faruq, A. Al, Hassan, M.M., Islam, K., Chakma, S., Hossain, M.B., 2016. Isolation, identification and antimicrobial resistance profile of *Staphylococcus aureus* in Cockroaches (*Periplaneta americana*). *J. Adv. Vet. Anim. Res.* 3, 221–228.
- Leshan Wannigama, D., Dwivedi, R., Zahraei-Ramazani, A., 2013. Prevalence and antibiotic resistance of gram-negative pathogenic bacteria species isolated from *periplaneta americana* and *blattella germanica* in Varanasi, India. *J. Arthropod. Borne. Dis.* 8, 10–20.
- Liu, Y., Yang, Y., Zhao, F., Fan, X., Zhong, W., Qiao, D., Cao, Y., 2013. Multi-drug resistant gram-negative enteric bacteria isolated from flies at Chengdu Airport, China. *Southeast Asian J. Trop. Med. Public Health* 44, 988–996.
- Lowe, C.F., Romney, M.G., 2011. Bedbugs as vectors for drug-resistant bacteria. *Emerg. Infect. Dis.* 17, 1132–1134. doi:10.3201/eid1706101978
- Ludvigsen, J., Amdam, G. V., Rudi, K., L'Abée-Lund, T.M., 2018. Detection and Characterization of Streptomycin Resistance (*strA-strB*) in a Honeybee Gut Symbiont (*Snodgrassella alvi*) and the Associated Risk of Antibiotic Resistance Transfer. *Microb. Ecol.* 76, 588–591. doi:10.1007/s00248-018-1171-7
- Matilla, F., Velleman, Y., Harrison, W., Nevel, M., 2018. Animal influence on water, sanitation and hygiene measures for zoonosis control at the household level: A systematic literature review. *PLoS Negl. Trop. Dis.* 12, 1–30. doi:10.1371/journal.pntd.0006619
- Milanović, V., Osimani, A., Pasquini, M., Aquilanti, L., Garofalo, C., Taccari, M., Cardinali, F., Riolo, P., Clementi, F., 2016. Getting insight into the prevalence of antibiotic resistance genes in specimens of marketed edible insects. *Int. J. Food Microbiol.* 227, 22–28. doi:10.1016/j.ijfoodmicro.2016.03.018
- Moges, F., Eshetie, S., Endris, M., Huruy, K., Muluye, D., Feleke, T., Silassie, F.G., Ayalew, G., Nagappan, R., 2016. Cockroaches as a Source of High Bacterial Pathogens with Multidrug Resistant Strains in Gondar Town, Ethiopia. *Biomed Res. Int.* 2016. doi:10.1155/2016/2825056
- Moreira, D.D.O., Morais, V. de, Vieira-da-Motta, O., Campos-Farinha, A.E. de C., Tonhasca Jr., A., 2005. Ants as carriers of antibiotic-resistant bacteria in hospitals. *Neotrop. Entomol.* 34, 999–1006. doi:10.1590/s1519-566x2005000600017
- Nmorsi, O.P.G., Agbozele, G., Ukwandu, N.C.D., 2007. Some aspects of epidemiology of filth flies: *Musca domestica*, *Musca domestica vicina*, *Drosophila melanogaster* and associated bacteria pathogens in Ekpoma, Nigeria. *Vector-Borne Zoonotic Dis.* 7, 107–117. doi:10.1089/vbz.2006.0539
- Obeng-Nkrumah, N., Labi, A.K., Blankson, H., Awuah-Mensah, G., Oduro-Mensah, D., Anum, J., Teye, J., Kwashie, S.D., Bako, E., Ayeh-Kumi, P.F., Asmah, R., 2018. Household cockroaches carry CTX-M-15, OXA-48 and NDM-1, and share beta-lactam resistance determinants with humans. *bioRxiv* 1–11. doi:10.1101/357079

- Onwugamba, F.C., Mellmann, A., Nwaugo, V.O., Süselbeck, B., Schaumburg, F., 2020. Antimicrobial resistant and enteropathogenic bacteria in 'filth flies': a cross-sectional study from Nigeria. *Sci. Rep.* 10, 1–9. doi:10.1038/s41598-020-74112-x
- Osimani, A., Garofalo, C., Aquilanti, L., Milanović, V., Cardinali, F., Taccari, M., Pasquini, M., Tavoletti, S., Clementi, F., 2017. Transferable antibiotic resistances in marketed edible grasshoppers (*Locusta migratoria migratorioides*). *J. Food Sci.* 82, 1184–1192. doi:10.1111/1750-3841.13700
- Pai, H.H., Chen, W.C., Peng, C.F., 2005. Isolation of bacteria with antibiotic resistance from household cockroaches (*Periplaneta americana* and *Blattella germanica*). *Acta Trop.* 93, 259–265. doi:10.1016/j.actatropica.2004.11.006
- Rahuma, N., Ghenghesh, K.S., Ben Aissa, R., Elamaari, A., 2005. Carriage by the housefly (*Musca domestica*) of multiple-antibiotic-resistant bacteria that are potentially pathogenic to humans, in hospital and other urban environments in Misurata, Libya. *Ann. Trop. Med. Parasitol.* 99, 795–802. doi:10.1179/136485905X65134
- Roncolini, A., Cardinali, F., Aquilanti, L., Milanović, V., Garofalo, C., Sabbatini, R., Abaker, M.S.S., Pandolfi, M., Pasquini, M., Tavoletti, S., Clementi, F., Osimani, A., 2019. Investigating Antibiotic Resistance Genes in Marketed Ready-to-Eat Small Crickets (*Acheta domesticus*). *J. Food Sci.* 84, 3222–3232. doi:10.1111/1750-3841.14818
- Sobur, A., Haque, Z.F., Sabuj, A.A.M., Levy, S., Rahman, A.M.M.T., El Zowalaty, M.E., Rahman, T., 2019. Molecular detection of multidrug and colistin-resistant *Escherichia coli* isolated from house flies in various environmental settings. *Future Microbiol.* 14, 847–858. doi:10.2217/fmb-2019-0053
- Solà-Ginés, M., González-López, J.J., Cameron-veas, K., Piedra-Carrasco, N., Cerdà-Cuellar, M., Migura-Garcia, L., 2015. Houseflies (*Musca domestica*) as vectors for extended-spectrum  $\beta$ -lactamase-producing *Escherichia coli* on Spanish broiler farms. *Appl. Environ. Microbiol.* 81, 3604–3611. doi:10.1128/AEM.04252-14
- Solomon, F., Kibru, G., Ali, S., 2018. Multidrug-resistant pattern of food borne illness associated bacteria isolated from cockroaches in meal serving facilities, Jimma, Ethiopia. *Afr. Health Sci.* 18, 32–40. doi:10.4314/ahs.v18i1.6
- Songe, M.M., Hang'ombe, B.M., Knight-Jones, T.J.D., Grace, D., 2017. Antimicrobial resistant enteropathogenic *Escherichia coli* and *Salmonella* spp. in houseflies infesting fish in food markets in Zambia. *Int. J. Environ. Res. Public Health* 14. doi:10.3390/ijerph14010021
- Tufa, T.B., Fuchs, A., Wienemann, T., Eggers, Y., Abdissa, S., Schneider, M., Jensen, B.E.O., Bode, J.G., Pfeffer, K., Häussinger, D., Mackenzie, C.R., Orth, H.M., Feldt, T., 2020. Carriage of ESBL-producing Gram-negative bacteria by flies captured in a hospital and its suburban surroundings in Ethiopia. *Antimicrob. Resist. Infect. Control* 9, 1–7. doi:10.1186/s13756-020-00836-0
- Vandeweyer, D., Milanović, V., Garofalo, C., Osimani, A., Clementi, F., Van Campenhout, L., Aquilanti, L., 2019. Real-time PCR detection and quantification of selected transferable antibiotic resistance genes in fresh edible insects from Belgium and the Netherlands. *Int. J. Food*

Microbiol. 290, 288–295. doi:10.1016/j.ijfoodmicro.2018.10.027

Vazirianzadeh, B., Dehghani, R., Mehdinejad, M., Sharififard, M., Nasirabadi, N., 2014. The First Report of Drug Resistant Bacteria Isolated from the Brown-Banded Cockroach, *Supella longipalpa*, in Ahvaz, South-western Iran. *J. Arthropod. Borne. Dis.* 8, 53–9.

Vriesekoop, F., Shaw, R., 2010. The Australian bush fly (*Musca vetustissima*) as a potential vector in the transmission of foodborne pathogens at outdoor eateries. *Foodborne Pathog. Dis.* 7, 275–279. doi:10.1089/fpd.2009.0366

Wetzker, W., Pfeifer, Y., Wolke, S., Haselbeck, A., Leistner, R., Kola, A., Gastmeier, P., Salm, F., 2019. Extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* isolated from flies in the urban center of Berlin, Germany. *Int. J. Environ. Res. Public Health* 16. doi:10.3390/ijerph16091530

Xu, Y., Tao, S., Hinkle, N., Harrison, M., Chen, J., 2018. Salmonella, including antibiotic-resistant Salmonella, from flies captured from cattle farms in Georgia, U.S.A. *Sci. Total Environ.* 616–617, 90–96. doi:10.1016/j.scitotenv.2017.10.324