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Enterobacter cloacae Complex Isolated from Shrimps from Vietnam Carrying bla_{IMI-1} Resistant to Carbapenems but Not Cephalosporins

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In August 2017, batches of *Penaeus monodon* (Asian tiger shrimp) and *P. vannamei* (White leg shrimp), originating from fish farms in Vietnam, were screened for the presence of carbapenemase-producing *Enterobacteriaceae* (CPE). An *Enterobacter cloacae* complex was isolated on a Chrom ID carba plate (bioMérieux Benelux BV), designated 3568. Susceptibility testing was performed according to ISO 20776-1:2006 with Sensititre panels EUVSEC and EUVSEC2 (Thermo Fisher, Waltham, MA, USA). Results are shown in Table 1. Interestingly, the isolate was resistant to ampicillin, cefoxitin, and carbapenems but not to third- and fourth-generation cephalosporins. No resistance to other antibiotics was measured.

DNA was isolated using a Gentra Puregene kit (Qiagen), and whole-genome sequencing was performed using MiSeq sequencing (Illumina). Contigs were compared to data in the Resfinder database, identifying bla_{IMI-1} as the only resistance gene (1). Comparison to other *Enterobacter* isolates encoding bla_{IMI-1} indicated that the gene is present on an EcloIMEX putative mobile genetic element (2). It is hypothesized that the EcloIMEX elements may be able to exit the chromosome through recombination mediated by the XerD/C recombinases, though this remains to be shown (3). The EcloIMEX element of strain 3568 was 99.94% identical to the element previously described in *Enterobacter cloacae* complex isolate DS31788 and is named here "EcloIMEX-7" (4).

EcloIMEX-1 encodes the carbapenemase bla_{NMC-A}, whereas EcloIMEX-2 to -7 encode bla_{IMI-1}. Most carbapenemases have hydrolytic activity against third- and fourth-generation cephalosporins, and several studies have reported carbapenem-resistant but cephalosporin-susceptible isolates (3–6). Although this is not completely unexpected considering the lower affinity that some of these enzymes have for these molecules (7), it is a trend that requires attention in monitoring and diagnostics in the clinic as mutants that are resistant due to increased expression may evolve rapidly when selected for by the presence of cephalosporins.

So far, EcloIMEX elements encoding IMI-1 have been found in 21 strains of 16 different multilocus sequence types (MLSTs) from Canada and China (4, 5). The isolate described here belongs to ST411 and is unrelated to the strains mentioned above, although the EcloIMEX-7 element is nearly identical to some of the elements previously described. This indicates that the EcloIMEX elements seem to spread among genetically diverse *Enterobacter* strains and may be mobilized through some mechanism for

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TABLE 1 MICs of various antibiotics for *E. cloacae* complex isolate 3568

Antibiotic	MIC (μg/ml)
β-Lactams	
Ampicillin	>64
Cefotaxime	≤0.25
Ceftazidime	0.5
Cefepime	≤0.06
Cefoxitin	>64
Temocillin	4
Carbapenems	
Ertapenem	>2
Imipenem	>16
Meropenem	16
Others	
Azithromycin	16
Chloramphenicol	≤8
Ciprofloxacin	0.03
Colistin	≤1
Gentamicin	≤0.5
Nalidixic acid	≤4
Sulfamethoxazole	≤8
Tetracycline	≤2
Tigecycline	≤0.25
Trimethoprim	0.5

horizontal transfer. All previously described isolates containing EcloIMEX elements were derived from human clinical samples, while strain 3568 was isolated from a sample of farmed shrimps from a geographically separated location.

Seafood imported from Southeast Asia was previously reported to contain carbapenemase-producing organisms; among aquatic microorganisms, however, such resistance genes are often encoded chromosomally in nonpathogenic organisms and therefore represent little cause for concern with respect to public health (8, 9). More recently, bla_{VIM-1} was reported on a plasmid in *Escherichia coli* and bla_{IMI-1} was found to be chromosomally located in an *E. cloacae* complex isolated from seafood sources (10, 11). These reports represent reasons to continue perform monitoring studies on seafood. With the limited data currently available, it is challenging to determine if seafood contributes to the rising prevalence of carbapenemase-producing microorganisms in humans.

Accession number(s). The data determined in this work are available through ENA accession no. PRJEB25936.

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