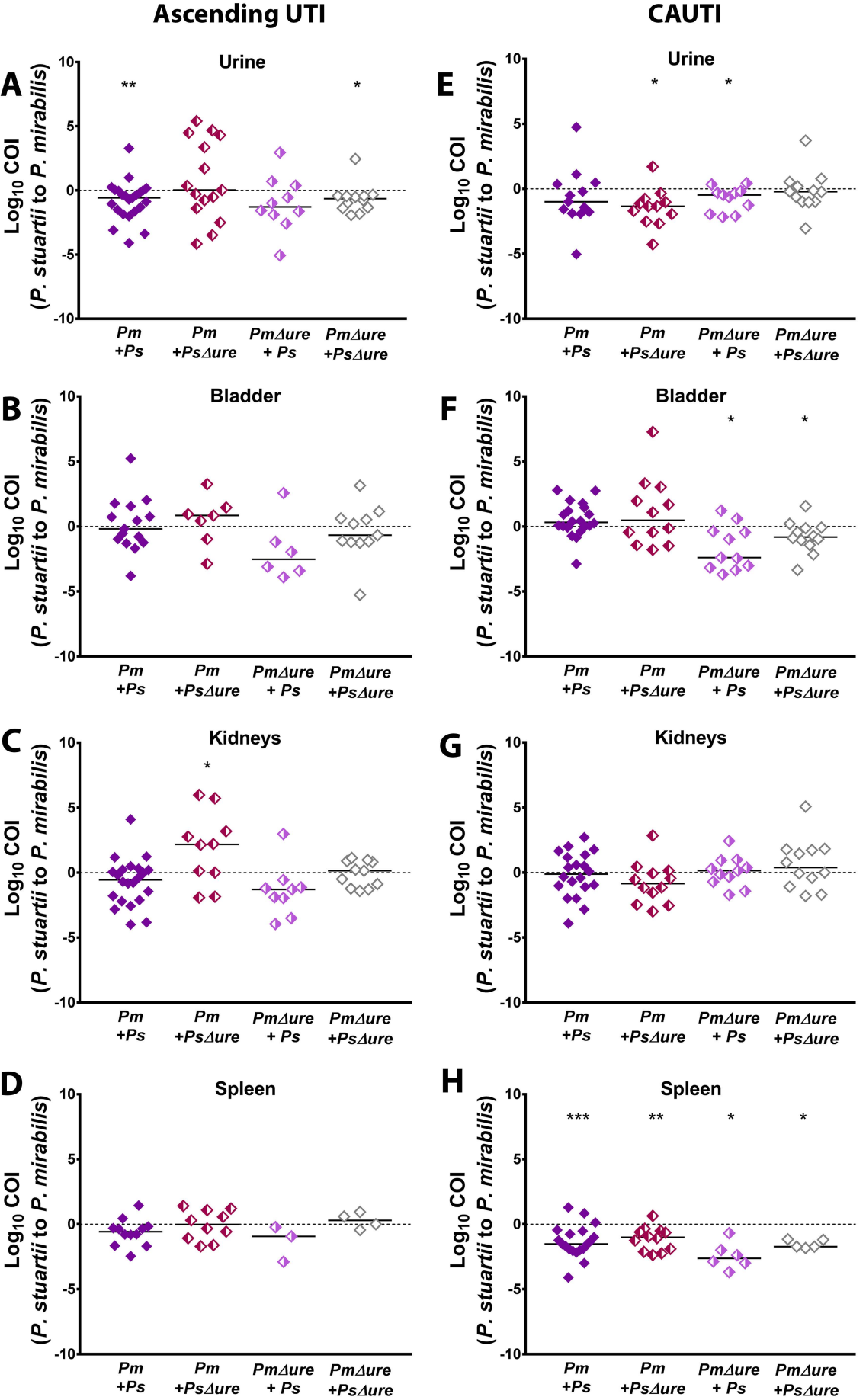
Fig S1: Coinfection provides only a modest advantage to any individual strain. Urine, bladder, kidney, and spleen homogenates from all mice were plated on LB agar to determine total CFU/gram tissue or ml urine), as well as LB agar supplemented with 20 μg/ml chloramphenicol to differentiate between *P. mirabilis* and *P. stuartii*. A coinfection index was calculated as follows for all samples in which bacterial burden was above the limit of detection:

$$\text{COI} = \frac{\textit{P. stuartii}\text{ CFUs from coinfected mouse}/\textit{P. mirabilis}\text{ CFUs from coinfected mouse}}{\text{Median }\textit{P. stuartii}\text{ CFUs from single infection}/\text{Median }\textit{P. mirabilis}\text{ CFUs from single infection}}$$

$Log_{10}COI=0$ indicates that the ratio of *P. stuartii* to *P. mirabilis* (or their respective urease mutants) from coinfected mice is the same as the ratio when comparing the median CFUs from single species infections. $Log_{10}COI>0$ indicates that the ratio favors *P. stuartii* either because *P. stuartii* colonized to a higher level during coinfection than single species infection, *P. mirabilis* colonized at a lower level than during single species infection, or some combination thereof. $Log_{10}COI<0$ indicates that the ratio favored *P. mirabilis*. (A and E) Urine COI, (B and F) bladder COI, (C and G) kidney COI, (D and H) spleen COI. Each symbol represents the COI for one mouse. Lines represent the median for a minimum of two independent experiments, at least five mice per infection group (total N of 11-23 per infection group). Dashed line indicates $Log_{10}COI=0$. $^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$ by Wilcoxon signed-rank test.


Ascending UTI
CAUTI
A
Urine
B
Bladder
C
Kidneys
D
Spleen
E
Urine
F
Bladder
G
Kidneys
H
Spleen
Log10 COI
(P. stuartii to P. mirabilis)
10
5
0
-5
-10
**
*
*
*
*
*
*
***
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*
*
Pm
+Ps
Pm
+PsΔure
PmΔure
+ Ps
PmΔure
+PsΔure

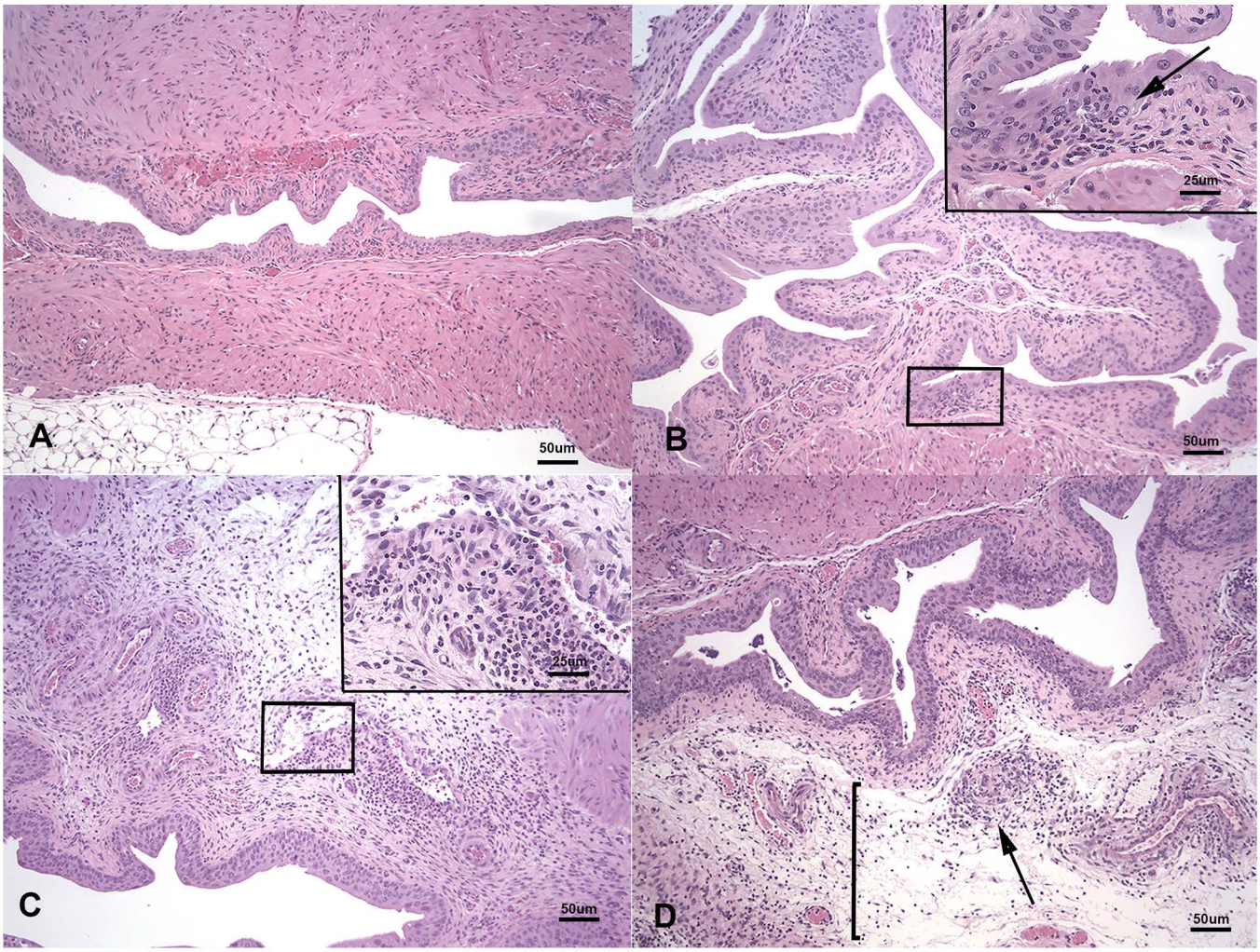

Fig S2: Representative bladder sections for scoring of cystitis. (A) Cystitis = 0; normal bladder. (B) Cystitis = 1; scattered neutrophils in submucosa and migrating through mucosa, inset is a higher magnification of boxed region showing neutrophils (arrow). (C) Cystitis = 2; mixed inflammation in the mucosa and submucosa and around vessels, inset is a higher magnification of boxed region indicating neutrophils translocating into the bladder lumen. (D) Cystitis = 3; widespread inflammation, thrombosed vessel (arrow), and marked submucosal edema (bracket).

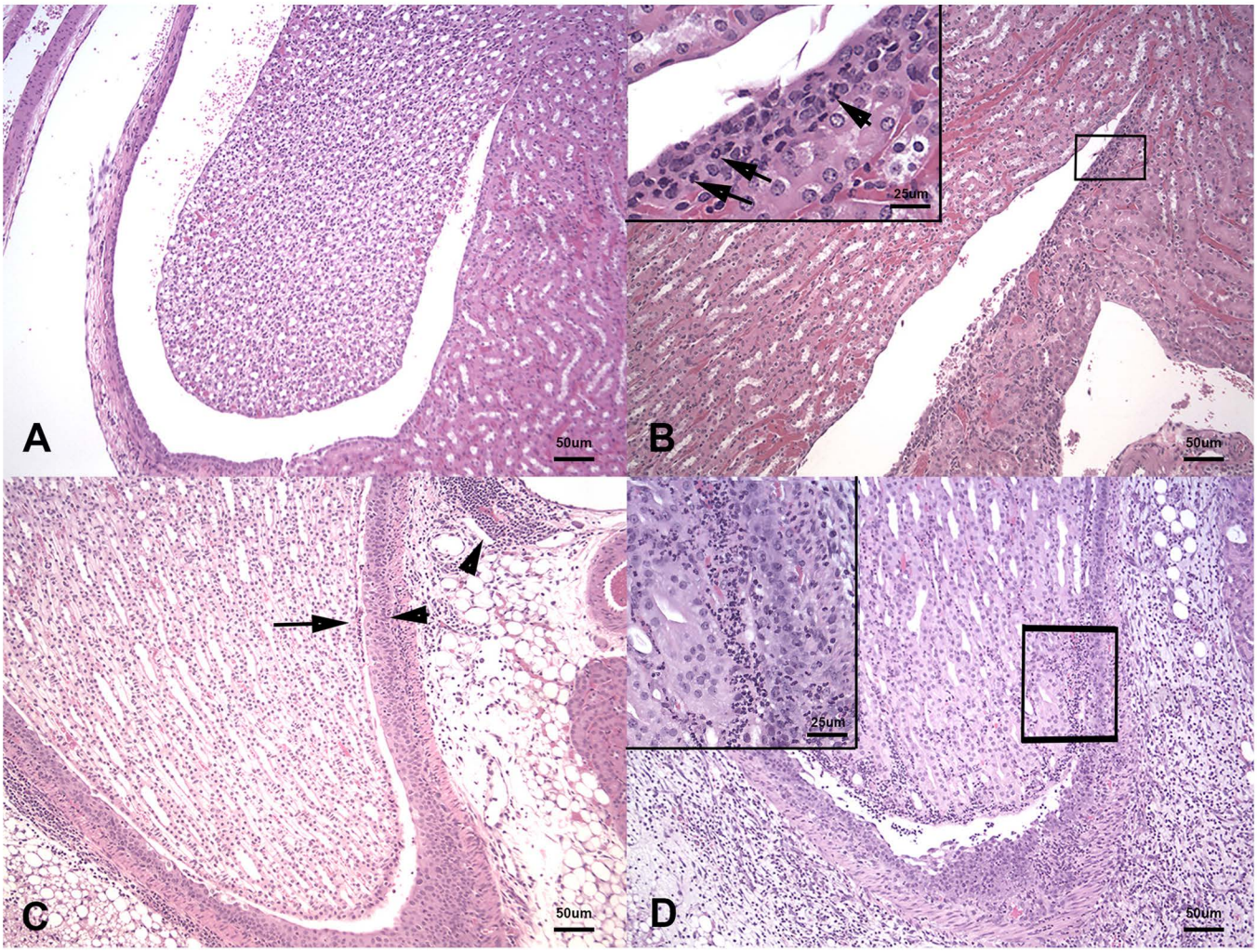

Fig S3: Representative renal pelvis sections for scoring of pyelonephritis. (A) Pyelonephritis = 0; normal renal pelvis. (B) Pyelonephritis = 1; scattered neutrophils migrating through pelvic epithelium, inset is a higher magnification of boxed region showing neutrophils (arrows). (C) Pyelonephritis = 2; clustered neutrophils in pelvic lumen (arrow) and inflammation within the epithelium (arrow) and surrounding stroma (arrowheads). (D) Pyelonephritis = 3; many neutrophils in pelvic lumen and within tissue, inset is a higher magnification of boxed region showing neutrophils.

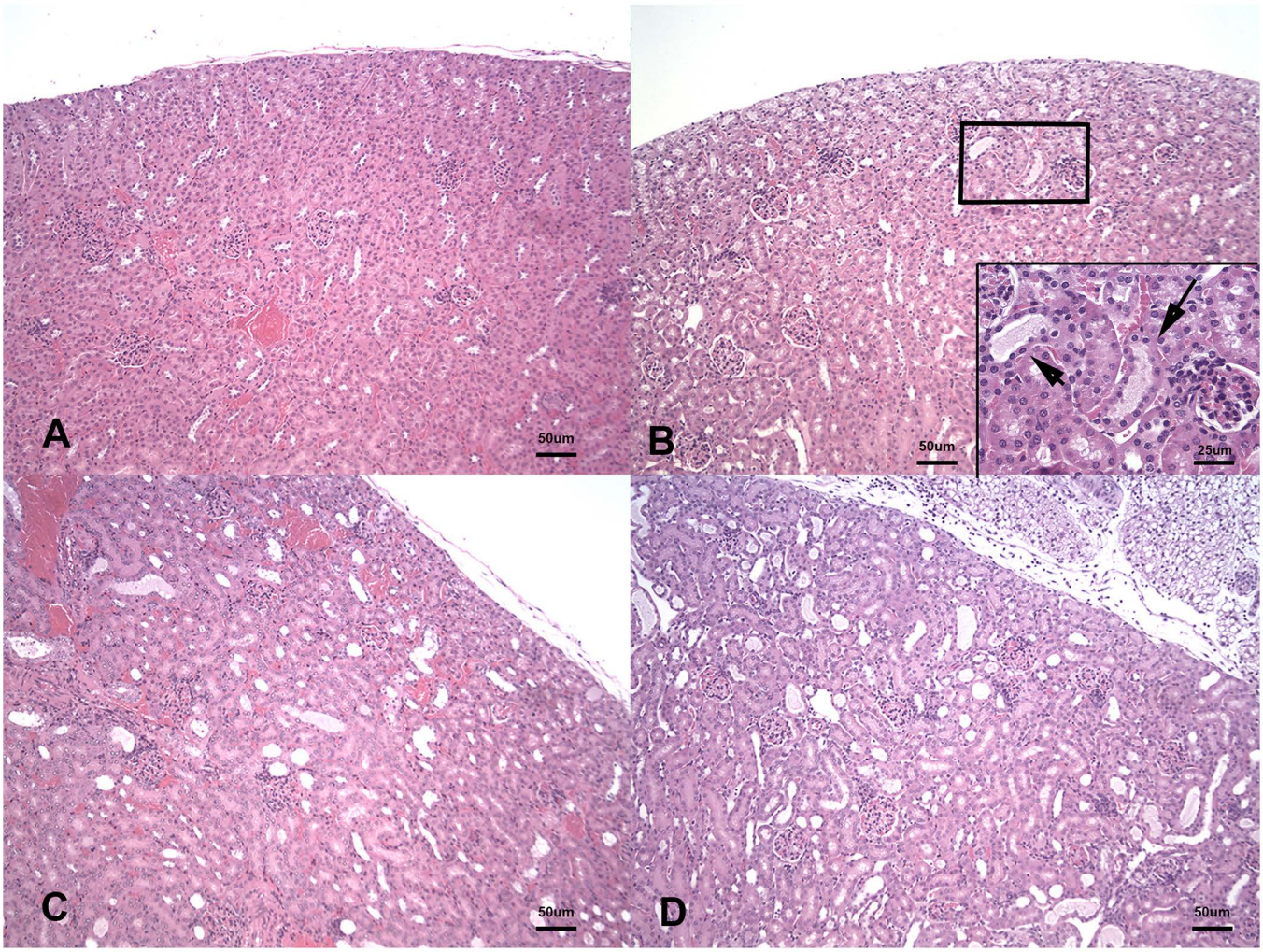

Fig S4: Representative renal cortex sections for scoring of nephrosis. (A) Nephrosis = 0; normal cortex. (B) Nephrosis=1; rare dilated tubules with proteinuria, inset is a higher magnification of boxed region showing dilated tubules and proteinuria (arrows). (C) Nephrosis = 2; dilated tubules and proteinuria more prominent. (D) Nephrosis = 3; most of cortex affected, widespread tubular epithelial atrophy and regeneration.

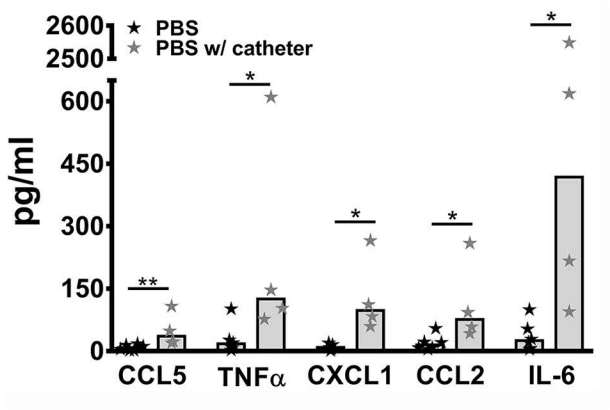

Fig S5. **Experimental CAUTI model induces proinflammatory response.** CBA/J mice were inoculated transurethrally with 50 µl of PBS, with or without insertion of a 4 mm segment of sterile silicone catheter tubing. A multiplexed bead-based immunoassay was used on urine samples collected at 24 hpi to quantify cytokines and chemokines. Gray bars representing the median, N=5 mice per infection group. **P*<0.05, ***P*<0.01, by Student's *t*-test.

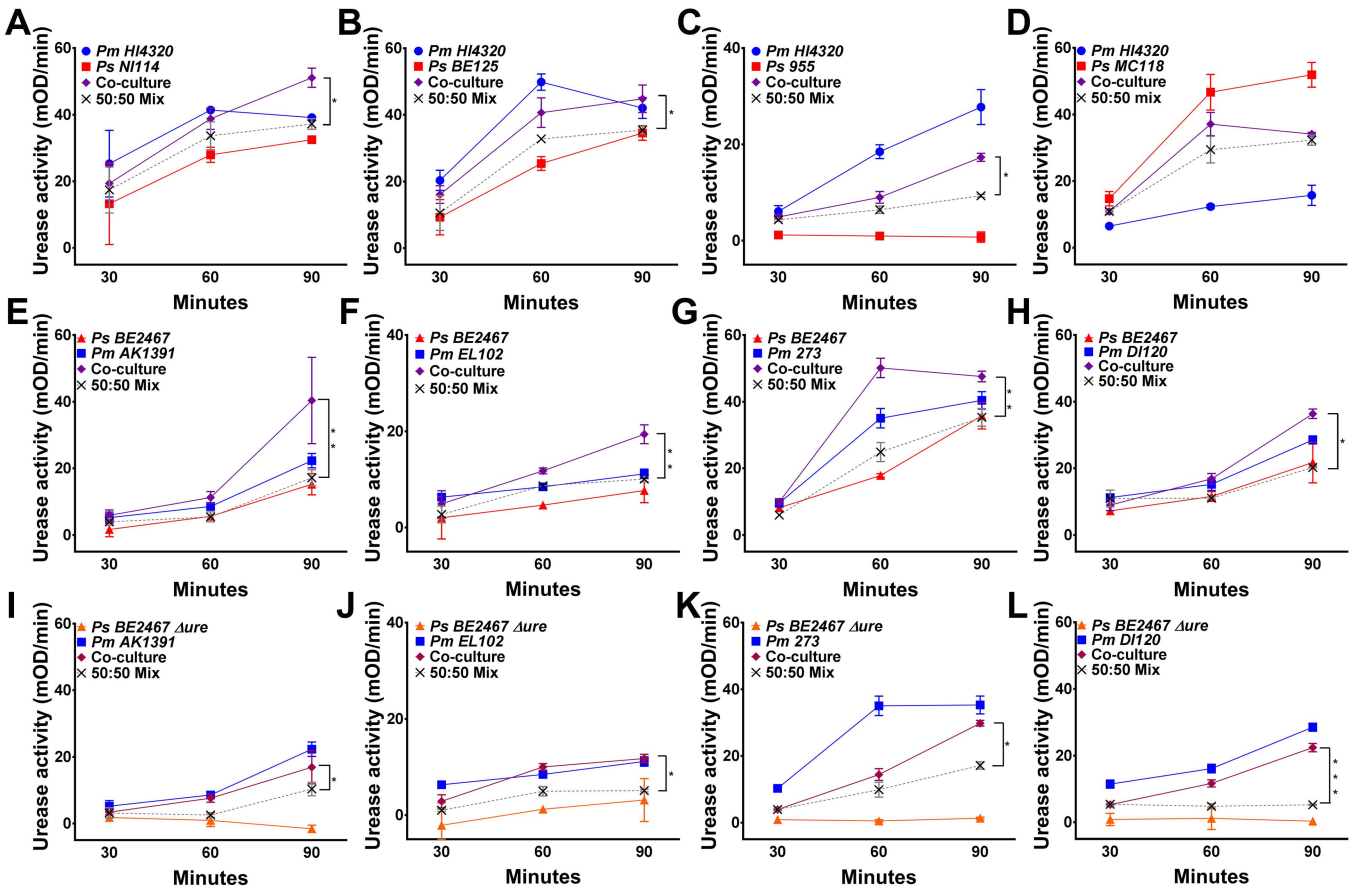

Fig S6. Enhanced urease activity occurs with numerous *Proteus mirabilis* and *Providencia stuartii* isolates. (A-D) *P. mirabilis* HI4320, (E-H) *P. stuartii* BE2467, and (I-L) *P. stuartii* BE2467 Δ*ure* were cultured for 90 minutes in filter-sterilized human urine individually or co-cultured with other *P. stuartii* (A-D) or *P. mirabilis* (E-L) isolates. Samples were taken at 30-minute intervals to measure urease activity, expressed as the mean optical density per minute (mOD/min) for a 5-minute kinetic read. Urease activity is shown for each isolate and co-culture compared to a 50:50 mixture of single species cultures at each time point. Graphs are representative of at least two independent experiments per strain. Error bars represent mean ± SD from at least three technical replicates. **P*<0.05, ***P*<0.01, ****P*<0.001 by two-way ANOVA.

Supplemental Table 1: Scoring System for Cystitis, Pyelonephritis, and Nephrosis

	Score			
	0	**1**	**2**	**3**
Pyelonephritis	NSL	Very occasional PMNs	Rafts of PMNs in the pelvis and/or scattered focal aggregates of PMNs in tissue	Many PMNs in all sections, or a single large focus of PMNs in one section
Cystitis	NSL	Very rare PMNs in stroma or lumen or occasional perivascular lymphoid cuffs)	Many PMNs and moderate edema	Many PMNs; widespread, marked edema, transmural inflammation
Nephrosis	NSL	Rare dilated tubules with epithelilal loss or regeneration	Affected tubules in many fields, easily identified	Most fields affected

NSL = no significant lesions; PMNs = polymorphonuclear leukocytes (neutrophils)

Supplemental Table 2: Enhanced Urease Activity During Co-culture of *P. mirabilis* and *P. stuartii* Isolates.

	Providencia stuartii				
Proteus mirabilis	BE2467	BE2467 Δ*ure*	955	NI114	MC118
HI4320	0.0016	0.0001	0.0230	0.0092	0.1649
HI4320 Δ*ure*	0.0593	0.5924	0.2579	0.3529	0.2408
DI120	0.0093	0.0003	0.0084	0.0337	0.6962
HU1069	0.0255	0.0074	0.0242	0.0001	0.0316
EL102	0.0068	0.0105	0.0010	0.0202	0.9022
AK1391	0.0077	0.0112	0.3573	0.0050	0.2533
273	0.0113	0.0289	0.0001	0.0443	0.6494

Green shading indicates combinations in which urease activity was significantly enhanced by co-culture compared to a 50:50 mixture of single species cultures at each time point. Blue shading indicates combinations in which co-culture did not significantly enhance urease activity. Numerical values indicate representative *P* values, by two-way ANOVA, from at least two independent experiments with four technical replicates for each strain.