

amoA- (upper right triangle) and AmoA (lower left triangle) gene sequence similarities of beta-subclass AOB. Included are all described species (depicted in bold), isolates investigated in this study and strains of the same species as the investigated isolates (proven by DNA-DNA hybridization). Included sequences were published by Aakra et al. (2001), McTavish et al. (1993), Norton et al. (2002), Purkhold et al. (2000) or determined in this study.

	<i>Nitrosospira</i> lineage																				<i>N. oligotropha</i> lineage					<i>N. marina</i> lineage			<i>N. europaea/Nc. mobilis</i> lineage				<i>N. communis</i> lineage				<i>Nitrosomonas</i> sp. Nm143 lineage	<i>N. croytolerans</i> lineage						
	III2	40KI	Nsp12	Nsp5	III7	B6	Nsp4	Nsp1	F3	Nsp40	Nsp10	Nsp62	Nv6	Nv12	NL13	NL5	Nsp17	Nsp2	L115	AF	Nsp41	Nv1	Ka3	Nsp57	Nsp58	Nsp65	Nm10	Nm84	Nm86	Nm59	Nm47	Nm45	Nm22	Nm36	Nm57	Nm50	Nc2A	Nm1	Nm2	Nm58	Nm90	Nm148	Nm143	Nm55
III2	98.3	97.3	97.6	89.9	86.6	86.2	86.7	85.3	86.2	86.0	88.4	83.6	83.8	85.0	83.6	84.1	84.8	86.5	86.5	86.5	88.4	91.3	87.4	89.4	83.6	74.4	78.3	80.4	78.3	79.0	79.7	78.7	74.6	71.7	71.5	68.4	75.1	71.0	70.3	72.0	72.2	77.5	76.1	
40KI	99.2		97.8	89.4	88.9	86.2	86.7	85.3	86.7	86.0	88.2	84.1	84.3	85.3	83.6	84.3	85.3	86.5	87.0	87.0	88.4	90.8	86.7	89.1	84.3	74.9	77.3	80.7	77.5	79.7	79.5	77.8	74.2	70.5	71.0	67.9	74.2	70.8	70.5	72.0	72.2	77.3	75.8	
Nsp12	99.2	100.0		97.8	88.7	88.4	85.0	85.4	84.1	85.7	86.1	87.6	84.3	84.5	84.5	83.2	83.7	84.3	85.2	85.7	86.5	86.5	89.4	87.0	89.4	83.7	74.0	77.0	80.4	77.7	79.0	78.8	77.0	74.8	69.5	69.5	68.0	73.5	69.5	70.4	70.9	71.1	77.3	75.1
Nsp5	99.2	100.0	100.0		89.4	88.6	85.4	86.5	84.8	86.8	86.3	88.1	84.5	84.8	85.0	83.4	84.5	84.8	86.1	86.2	87.0	87.6	90.3	87.0	89.4	85.0	74.2	77.0	80.6	77.7	79.7	79.5	77.0	75.1	69.5	69.8	67.3	73.1	70.0	70.2	71.3	71.5	77.3	75.3
III7	99.2	98.5	98.6	98.6		95.9	85.9	87.2	85.7	87.4	87.6	89.4	85.2	85.0	85.7	84.3	86.1	85.9	87.9	87.7	87.6	89.0	91.2	90.1	92.5	85.4	74.0	75.9	78.1	77.9	78.1	77.7	77.0	75.7	70.6	71.7	65.1	72.2	69.5	70.0	70.6	70.4	77.0	75.7
B6	97.7	98.4	98.4	98.4	98.4		86.5	86.7	86.5	87.4	87.4	88.9	86.0	85.7	87.0	84.8	85.7	86.2	88.2	88.2	87.9	89.4	90.8	89.4	92.5	85.5	74.9	75.6	79.0	77.3	78.3	77.5	76.8	74.4	70.3	72.7	66.7	73.9	69.1	71.3	71.0	70.8	75.8	75.6
Nsp4	93.1	93.8	94.3	94.3	93.8		95.6	93.0	92.7	87.9	89.4	86.3	85.9	83.4	83.9	85.9	85.0	86.5	87.4	84.1	86.5	86.5	85.2	86.8	82.6	71.3	73.5	77.3	74.6	76.4	77.3	74.0	72.0	70.1	70.5	64.9	71.7	69.1	69.5	68.7	68.4	73.3	74.2	
Nsp1	93.1	93.8	94.3	94.3	93.8	97.9		95.7	95.1	90.1	92.3	87.6	87.2	83.7	83.2	86.8	86.8	87.6	87.7	86.5	87.6	87.6	87.6	89.4	82.8	71.3	73.5	77.0	74.8	77.3	77.7	74.6	72.6	69.1	69.8	64.9	71.7	69.5	70.0	69.3	69.1	73.3	74.4	
F3	93.1	93.8	93.8	93.8	93.8	95.4	96.2		92.8	87.7	90.1	87.2	86.7	82.9	83.3	84.5	84.5	87.7	87.9	84.8	86.8	86.7	87.4	88.4	82.9	70.5	72.5	75.6	74.2	77.1	77.5	73.7	71.3	68.8	70.8	64.5	72.0	68.8	70.0	68.8	68.6	72.0	72.7	
Nsp40	92.3	93.1	93.6	93.6	93.0	96.5	97.9	96.2		90.3	91.2	88.5	88.1	85.2	85.0	85.9	85.9	87.6	88.4	87.0	87.6	87.6	87.6	87.2	89.0	82.8	71.3	72.8	76.6	73.7	76.4	76.6	73.5	71.3	69.1	69.8	64.5	71.7	68.7	69.1	69.1	68.9	72.0	73.3
Nsp10	93.8	94.6	95.0	95.0	95.0	94.6	95.9	95.4	97.2		92.1	86.5	86.3	87.2	87.0	85.9	85.9	88.3	87.0	87.6	86.8	86.3	89.4	90.3	84.3	74.8	75.3	78.4	76.8	77.7	77.7	76.8	75.7	69.1	68.4	64.7	71.7	69.5	68.7	70.2	70.0	75.5	74.8	
Nsp62	93.1	93.8	94.3	94.3	94.3	93.8	95.1	97.2	95.4	96.5	97.9		88.5	88.3	88.3	86.1	87.9	87.9	90.1	90.3	87.6	90.3	88.5	90.3	92.5	84.1	74.2	75.5	79.2	77.5	78.6	78.6	76.8	74.2	70.2	70.4	65.6	73.7	71.1	70.2	70.9	70.6	74.6	74.8
Nv6	90.8	91.5	92.1	92.1	91.5	92.1	91.5	94.7	95.1	93.7	94.4		99.1	86.1	85.7	85.4	85.9	87.4	86.2	84.8	88.3	85.2	85.2	86.5	82.3	74.4	76.4	78.6	77.9	78.6	78.6	76.8	73.7	69.8	71.1	65.3	73.7	70.9	71.3	69.5	69.5	75.1	75.1	
Nv12	90.0	90.8	91.4	91.4	91.4	90.7	93.0	94.4	93.9	94.4	93.0	93.7	99.3		85.9	85.9	85.2	85.7	87.2	86.0	85.0	85.4	85.4	85.4	86.8	82.1	74.6	76.2	78.8	78.1	78.8	78.4	76.6	74.0	69.9	71.2	65.6	73.5	71.3	71.7	69.8	69.8	75.3	75.3
NL13	92.3	93.1	92.9	92.9	92.9	94.6	92.2	92.9	92.3	93.6	95.0	94.3	91.5	90.8		87.4	85.7	85.7	86.8	86.5	84.1	87.4	85.2	86.5	89.4	83.4	75.5	76.8	78.8	76.6	77.0	76.8	77.5	74.6	70.6	72.2	67.1	73.3	69.5	72.2	70.6	70.4	77.7	75.1
NL5	90.0	90.8	90.7	90.7	90.7	92.2	90.1	90.8	90.1	91.5	93.0	93.7	90.8	90.1	96.5		84.3	85.4	85.3	84.1	85.4	83.9	85.4	85.0	80.8	74.4	74.4	77.5	75.7	76.6	76.2	75.7	74.6	72.0	71.3	64.7	73.1	69.1	69.8	71.5	71.7	76.2	74.4	
Nsp17	91.5	92.3	92.9	92.9	92.9	93.8	90.8	91.5	89.2	89.4	92.2	91.5	89.4	88.7	93.6	94.3		91.4	88.7	88.4	83.9	87.2	85.9	85.9	87.9	84.3	75.7	76.8	80.8	77.7	79.0	78.8	77.3	74.4	70.2	71.1	68.0	71.7	69.3	70.9	70.6	70.4	77.9	74.8
Nsp2	93.1	93.8	93.6	93.6	93.6	93.3	90.1	90.8	89.2	88.7	91.5	90.8	87.9	87.2	92.2	92.9	95.0		88.5	88.9	85.4	87.2	85.9	85.2	89.0	83.7	75.1	76.2	80.1	77.7	78.6	78.6	77.5	74.8	69.8	71.5	67.1	70.9	69.3	70.4	70.2	70.0	76.4	74.8
L115	94.6	95.4	96.0	95.0	95.0	96.3	92.2	92.2	93.1	92.9	92.9	93.6	91.5	90.8	95.0	94.3	93.6	92.9		95.2	86.5	92.5	89.0	86.8	89.6	86.3	75.5	76.4	78.6	77.7	79.0	79.7	76.8	76.4	69.8	70.9	64.9	73.3	70.4	70.0	70.4	70.4	76.6	74.4
AF	95.4	96.2	96.2	96.2	96.1	93.1	93.1	93.9	93.9	93.9	94.7	92.4	91.6	95.4	93.1	93.1	93.1	99.2		85.5	91.3	87.2	86.5	89.9	85.5	75.4	75.4	77.3	76.8	78.3	76.8	75.4	73.2	73.7	67.1	74.4	70.8	72.5	71.3	71.3	76.6	74.4		
Nsp41	92.3	93.1	92.9	92.9	92.9	94.6	91.4	91.4	90.8	91.4	90.7	90.7	89.3	88.6	91.4	90.8	92.1	92.1	93.6	93.8		85.9	88.1	86.1	89.6	81.0	73.7	73.5	77.9	74.6	75.9	75.7	74.6	68.9	68.9	66.2	72.4	69.3	71.3	72.8	72.6	74.6	73.3	
Nv1	95.4	96.2	95.7	95.7	95.7	96.1	93.6	94.3	93.8	93.6	95.0	95.7	92.9	92.1	97.1	95.0	94.3	93.6	97.9	98.5	92.9		89.6	86.8	89.0	86.8	76.6	76.8	79.5	78.1	79.7	79.5	75.9	74.8	70.6	71.3	66.0	71.7	70.0	70.4	71.5	71.5	76.6	75.3
Ka3	98.5	97.7	97.9	97.9	99.3	99.2	93.6	93.6	93.1	92.9	94.3	93.6	91.4	90.7	93.6	91.4	93.6	94.3	94.3	94.4	93.6	95.0		89.8	92.5	86.1	74.8	74.6	79.0	76.6	77.0	77.3	75.9	74.4	67.3	69.8	64.9	72.4	70.2	69.5	69.8	69.8	76.6	75.5
Nsp57	96.2	96.9	97.1	97.1	97.1	98.4	95.0	95.7	93.8	93.6	96.4	95.7	92.9	92.1	94.3	93.6	94.3	95.0	93.6	94.6	92.9	95.7	97.9		93.2	84.5	74.0	75.3	78.1	76.8	77.9	78.4	76.4	74.4	69.5	70.0	65.1	73.3	70.6	70.4	70.4	70.2	75.5	76.8
Nsp58	97.7	98.5	98.6	98.6	98.6	100.0	94.3	94.3	93.8	93.6	95.0	94.3	92.1	91.4	94.3	92.1	94.3	95.0	95.0	96.2	94.3	95.7	99.3	98.6		86.3	73.5	75.3	79.0	76.6	78.4	76.4	74.8	74.4	69.1	70.4	64.9	73.1	70.4	70.2	69.5	69.3	75.7	75.3
Nsp65	93.1	93.8	93.6	93.6	93.8	90.1	90.1	90.1	89.4	90.8	90.1	87.9	87.2	90.0	88.7	86.6	89.3	92.2	92.4	88.6	92.9	92.9	92.9	93.6		72.2	74.2	75.7	74.8	75.9	76.2	74.2	73.5	67.5	69.5	64.7	71.3	69.1	68.7	68.4	68.2	75.3	73.3	
Nm10	87.7	87.7	87.1	87.1	86.4	87.6	83.7	83.7	84.6	82.3	84.4	83.7	83.0	82.3	85.1	85.1	85.8	85.8	87.1	86.9	85.0	86.4	87.1	86.4	87.1	82.1	86.3	86.8	85.9	86.1	86.1	82.3	83.9	73.1	74.4	72.2	71.1	74.2	75.3	76.6	76.8	86.2	79.9	
Nm84	89.2	89.2	89.3	89.3	88.6	87.6	85.8	85.8	86.2	84.4	86.5	85.8	85.1	84.4	85.8	85.8	86.5	85.8	89.3	88.5	85.0	88.6	87.9	87.1	87.9	84.3	96.5	97.2	90.1	91.2	89.6	89.6	82.8	83.2	74.6	75.3	71.1	73.3	75.1	74.8	76.2	76.6	82.6	80.6
Nm86	89.2	89.2	89.3	89.3	88.6	89.1	85.8	85.8	86.2	84.4	86.5	85.8	85.8	85.1	87.9	87.9	89.4	87.2	89.3	88.5	86.4	88.6	89.3	88.6	89.3	84.3	96.5	97.2	89.6	91.4	90.9	84.5	82.1	73.7	74.6	70.9	74.6	73.3	77.0	75.5	75.7	83.0	81.0	