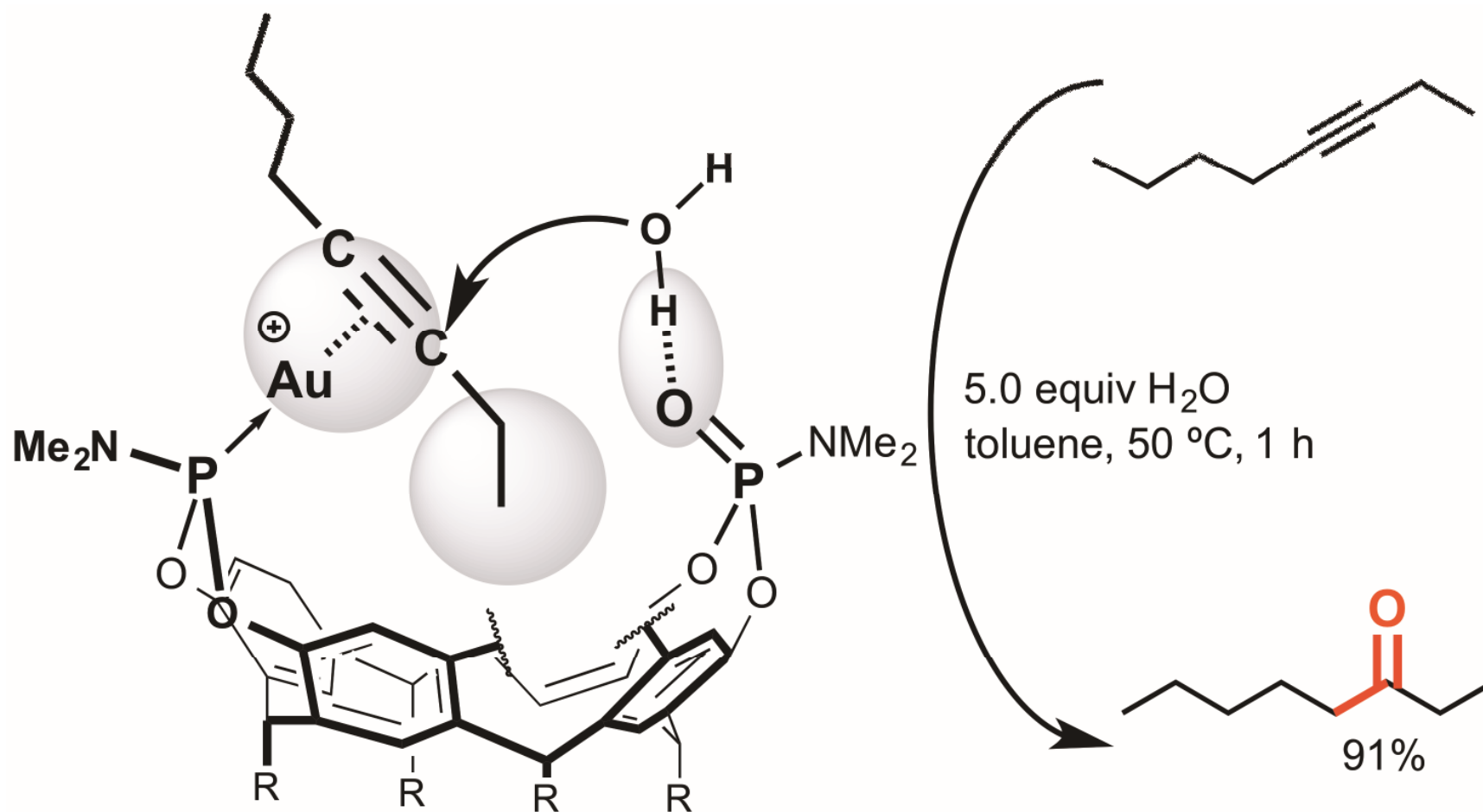
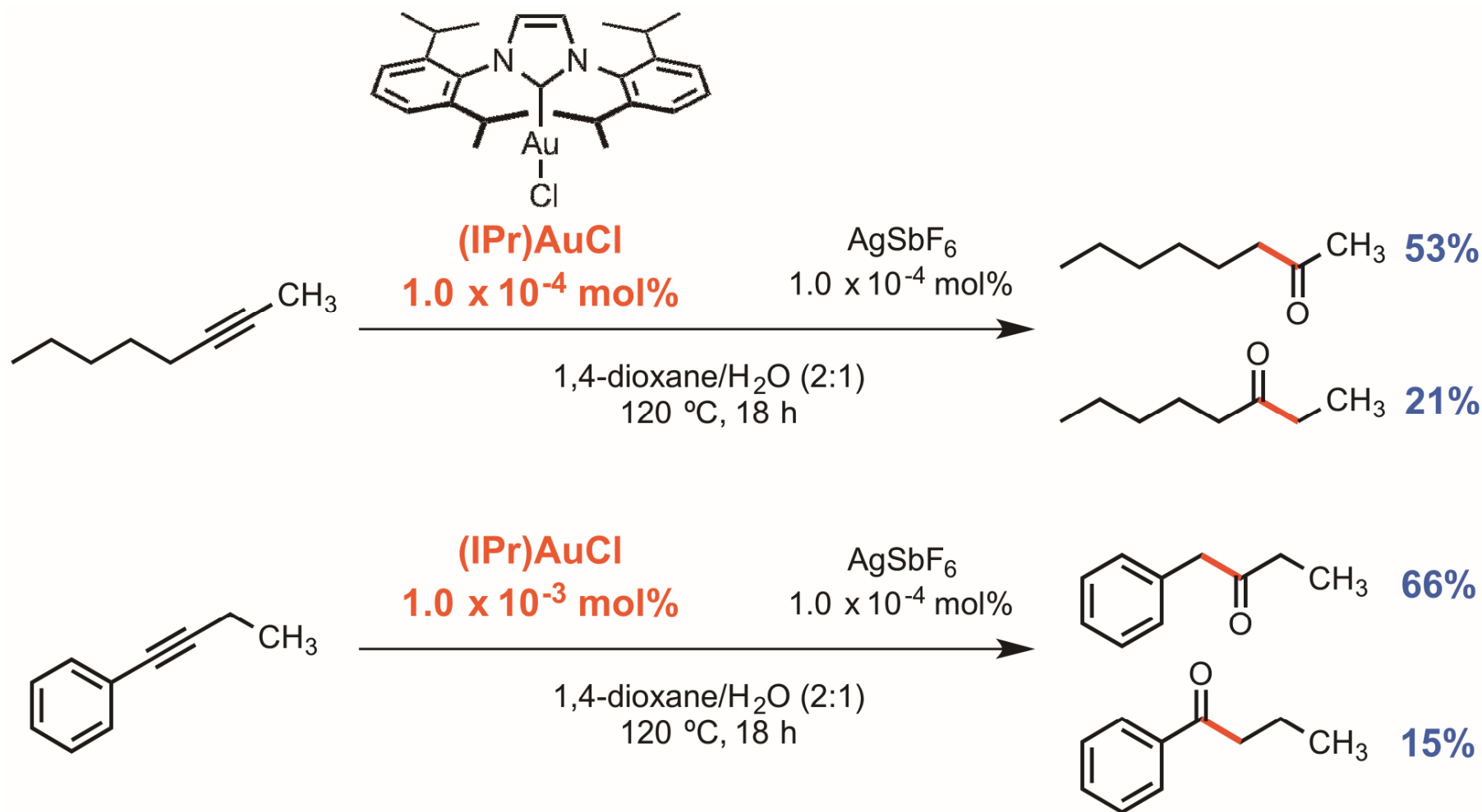


Evaluation of Cavitation-driven Catalysis for Selective Hydration of Internal Alkynes



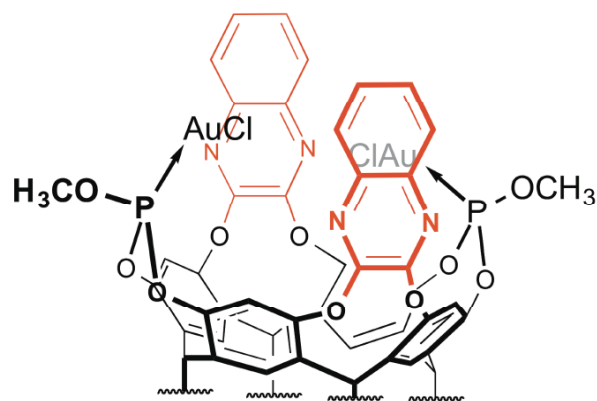
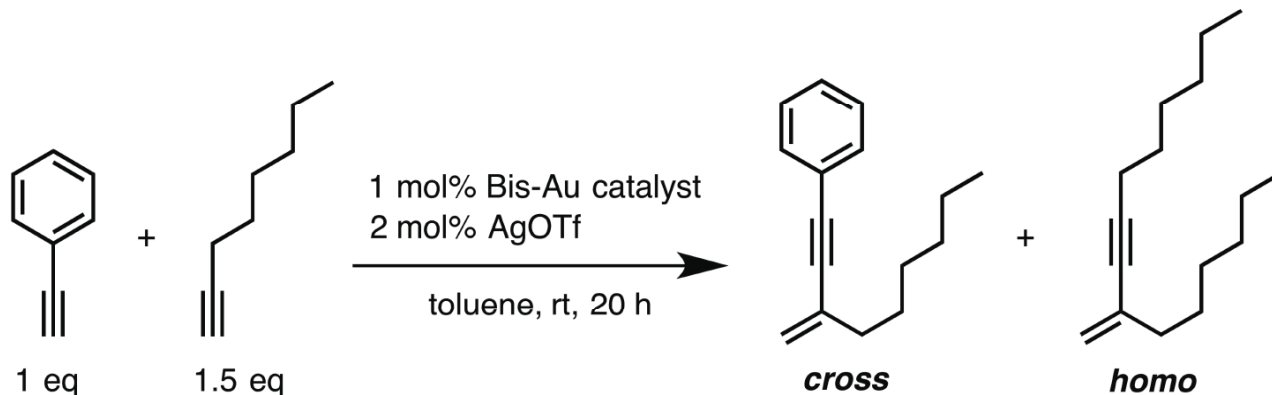
1. N. Endo, M. Inoue, T. Iwasawa, *Eur. J. Org. Chem.* **2018**, 1136-1140. (VIP)
2. M. Inoue, K. Ugawa, T. Maruyama, T. Iwasawa, *Eur. J. Org. Chem.* **2018**, 5304-5311.

Background; the Au-catalyzed hydration of internal alkynes resulted in terribly isomeric production of ketones.

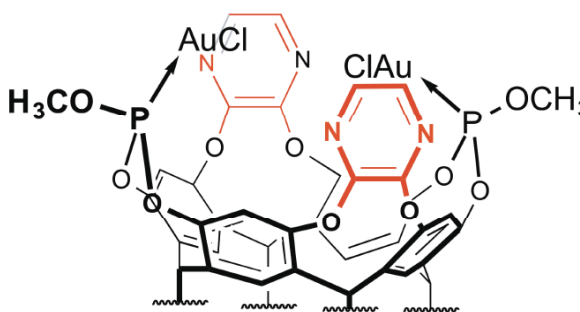


N. Marion, R. S. Ramon, S. P. Nolan, *J. Am. Chem. Soc.*, **2009**, 131, 448-449.

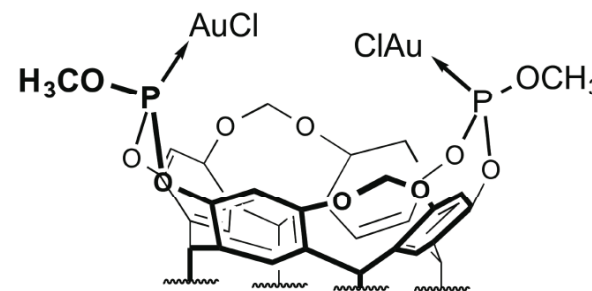
Our background; cavitand-recessed type metal catalysts have been developed.



***cross* 58%**
***homo* 19%**



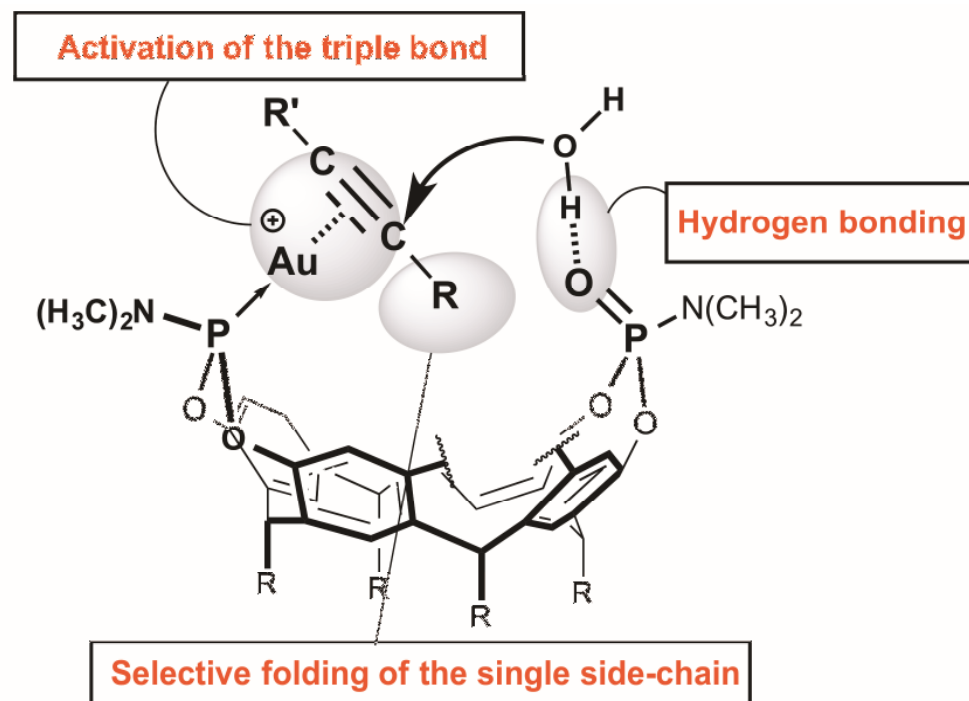
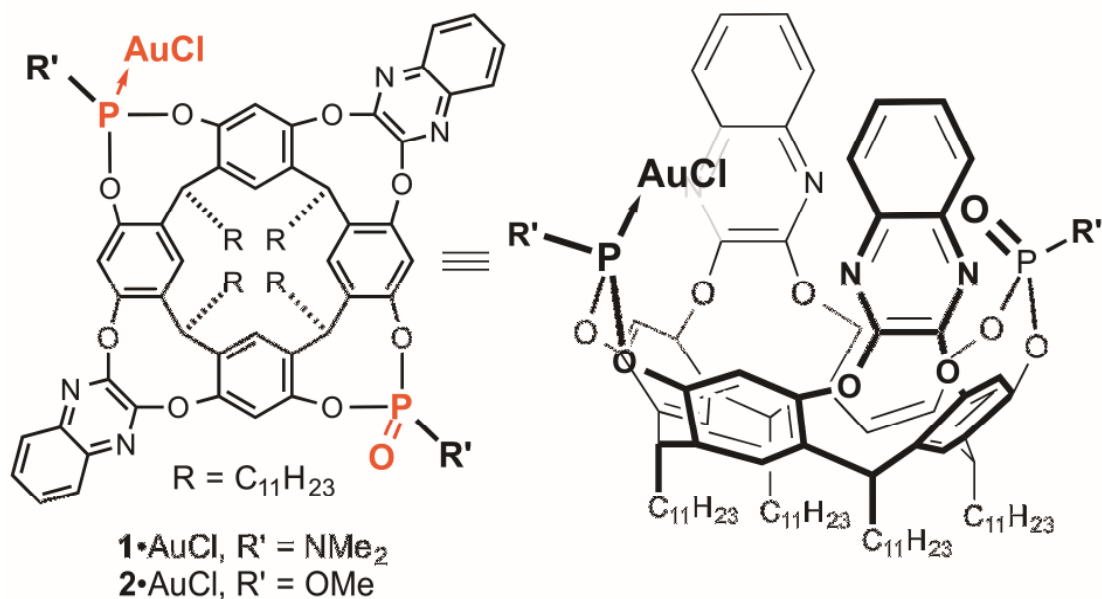
***cross* 6%**
***homo* 1%**



0%
No reaction

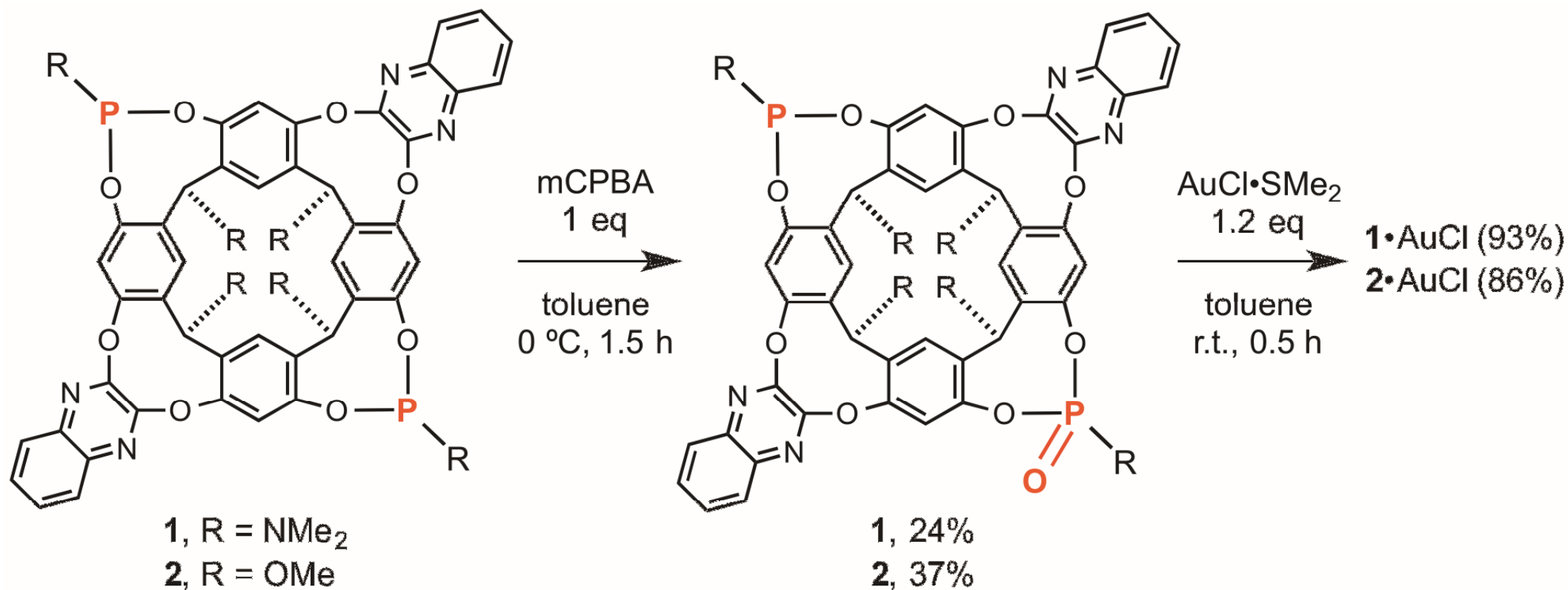
M. Kanaura, N. Endo, M. P. Schramm, T. Iwasawa, *Eur. J. Org. Chem.* **2016**, 4970-4975.

**Approach to the selective production of ketones:
Lewis acidic Au^+ , Lewis basic $\text{O}=\text{P}$, and narrow
space, these cooperatively recognize the single
carbon of alkynyl triple bonds.**

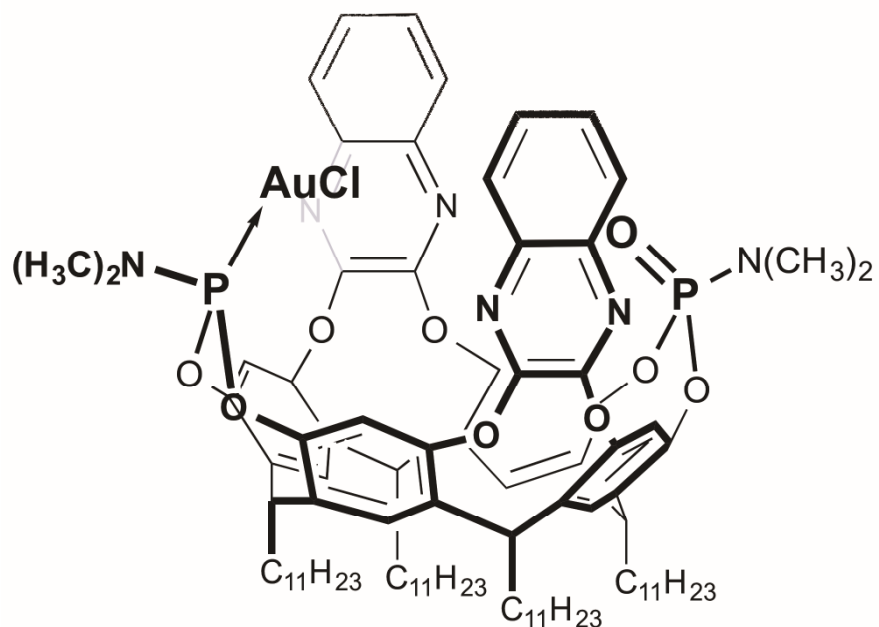
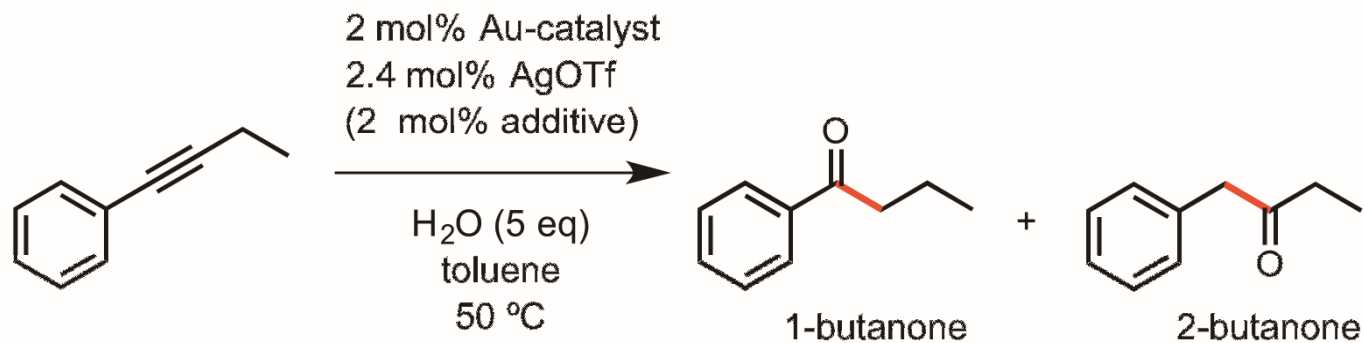


Synthesis of the bi-functional cavitand was achieved, referring to our previous report.

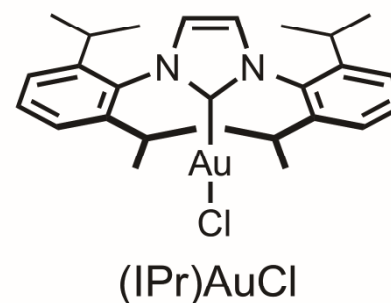
1. N. Endo, M. Kanaura, M. P. Schramm, T. Iwasawa, *Eur. J. Org. Chem.* **2016**, 2514-2521.
2. M. Kanaura, N. Endo, M. P. Schramm, T. Iwasawa, *Eur. J. Org. Chem.* **2016**, 4970-4975.



It selectively catalyzed 1-phenyl-1-butyne, giving a 2:98 ratio; however, (IPr)AuCl didn't.



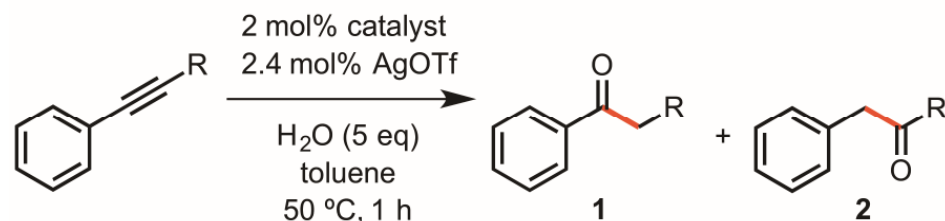
1 h
1-butanone 2%
2-butanone 98%



4 h
1-butanone 18%
2-butanone 56%

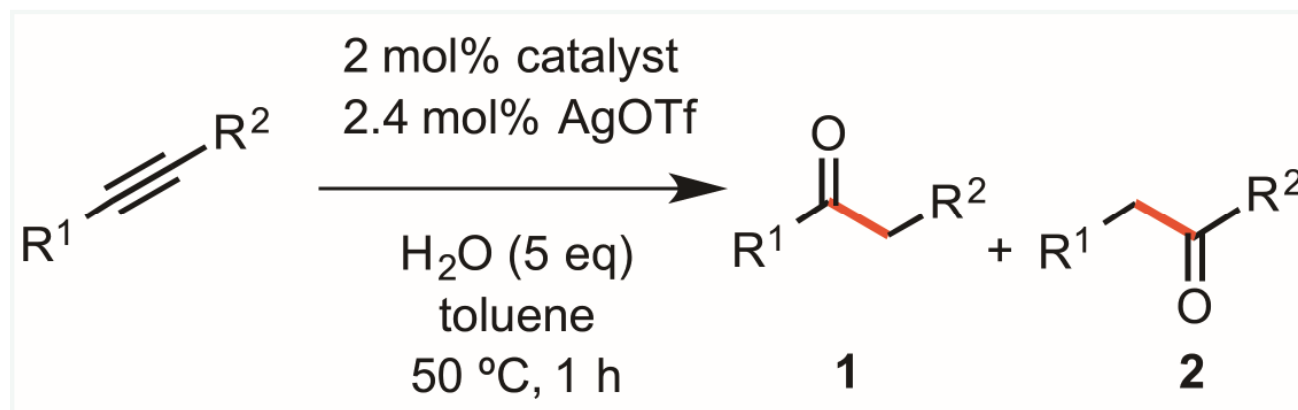
with O=PPh₃
4 h
1-butanone 16%
2-butanone 68%

Elongation of alkyl side-chains clearly influenced the cavitand catalysis, while (IPr)AuCl didn't.



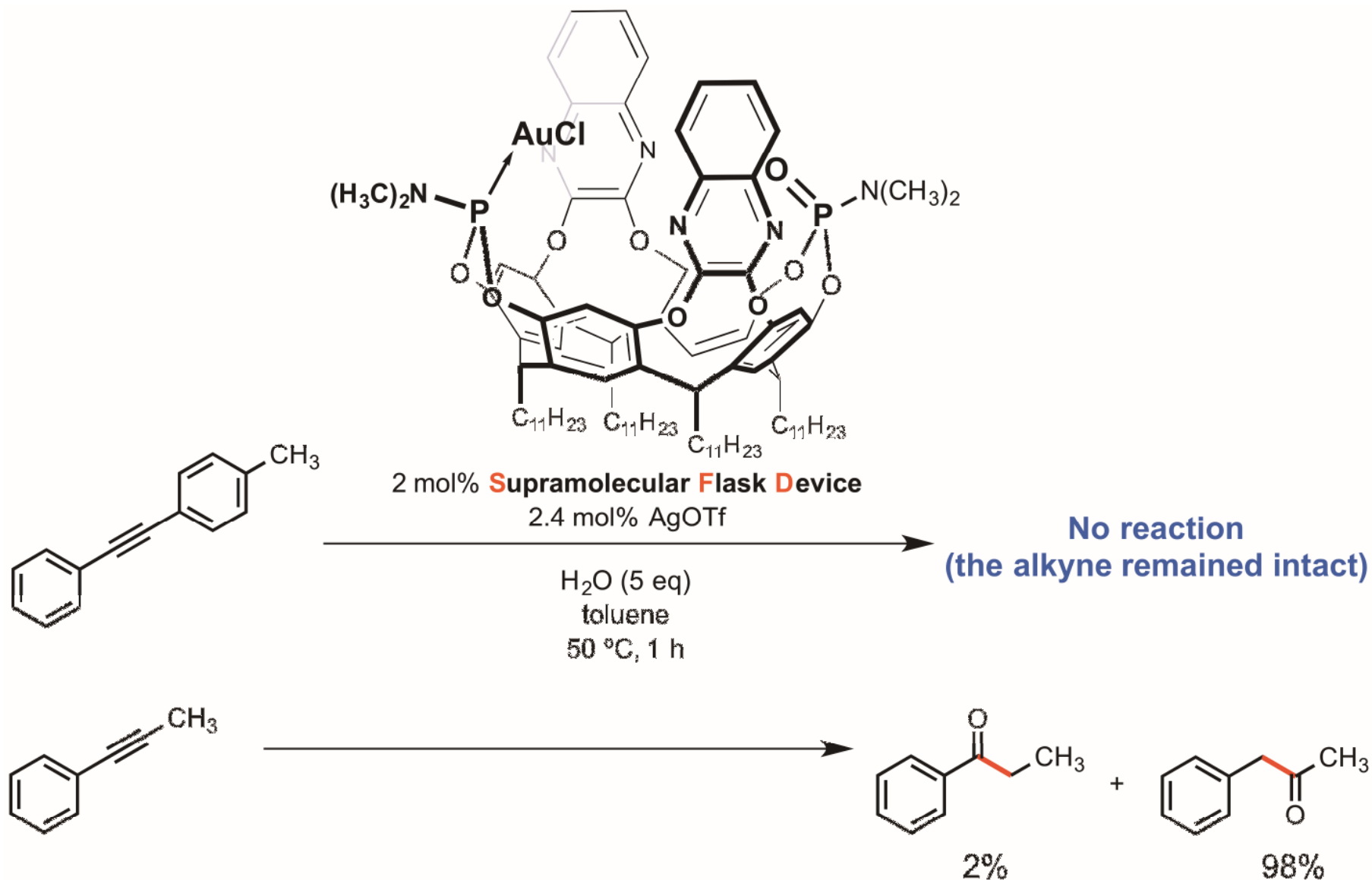
Catalyst	R	%Yield		
		unreacted alkyne	1	2
Cavitand (NMe ₂)•AuCl	H	100	0	0
	CH ₃	0	2	98
	C ₂ H ₅	0	2	98
	<i>n</i> -C ₃ H ₇	51	16	33
	<i>n</i> -C ₄ H ₉	87	10	3
	<i>n</i> -C ₇ H ₁₅	100	0	0
(IPr)AuCl and O=PPh ₃	H	100	0	0
	CH ₃	96	2	2
	C ₂ H ₅	70	4	17
	<i>n</i> -C ₃ H ₇	88	5	7
	<i>n</i> -C ₄ H ₉	61	11	28
	<i>n</i> -C ₇ H ₁₅	94	3	3

Isomeric octynes were studied: Me and Et groups seem to be selectively folded inside the space.

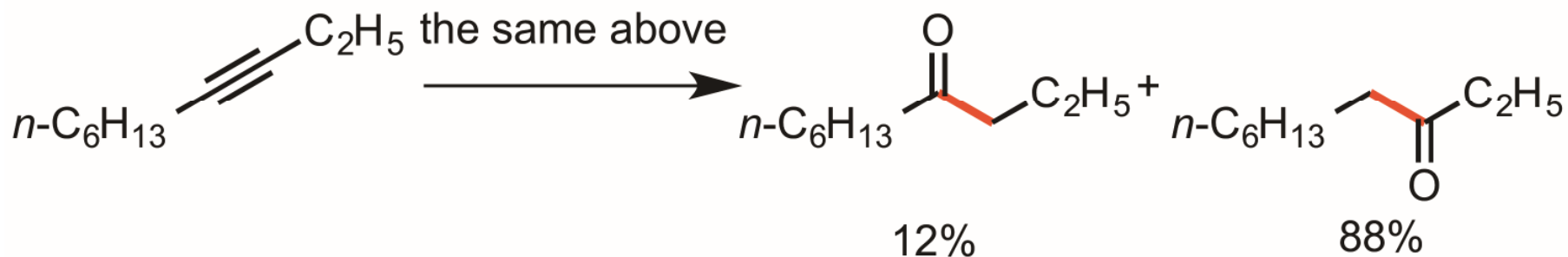
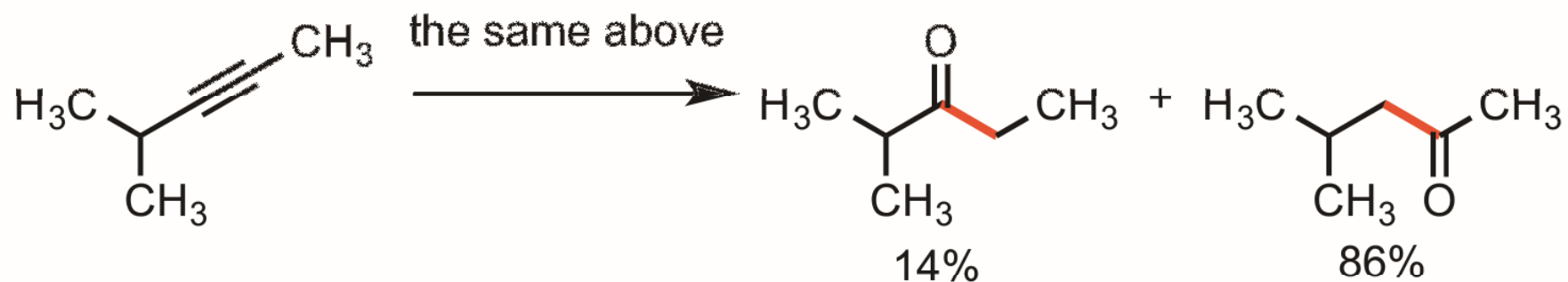
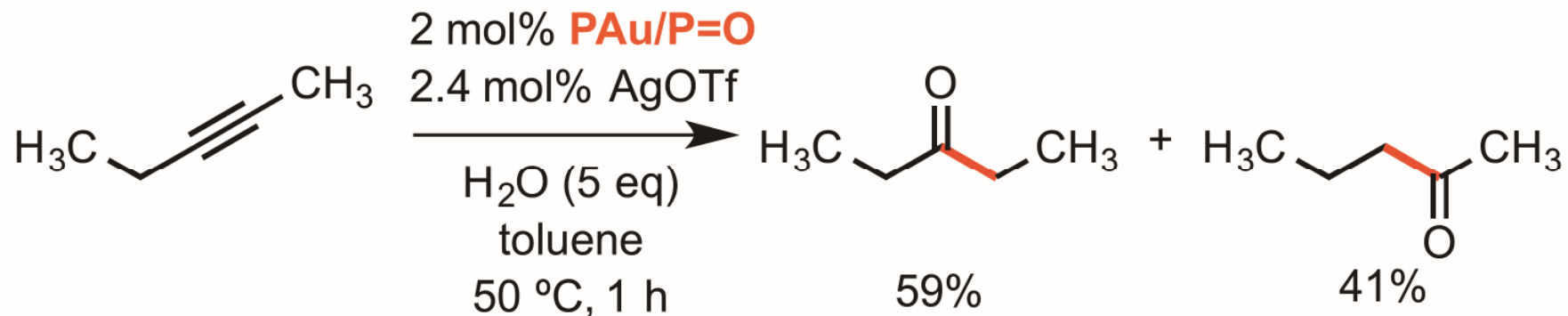


Catalyst	R ¹	R ²	%Yield		
			unreacted octyne	1	2
Cavitand (NMe ₂)•AuCl	<i>n</i> -C ₄ H ₉	C ₂ H ₅	0	9	91
	<i>n</i> -C ₅ H ₁₁	CH ₃	0	18	82
	<i>n</i> -C ₆ H ₁₃	H	100	0	0
(IPr)AuCl and O=PPh ₃	<i>n</i> -C ₄ H ₉	C ₂ H ₅	64	13	23
	<i>n</i> -C ₅ H ₁₁	CH ₃	40	21	39
	<i>n</i> -C ₆ H ₁₃	H	74	26	0

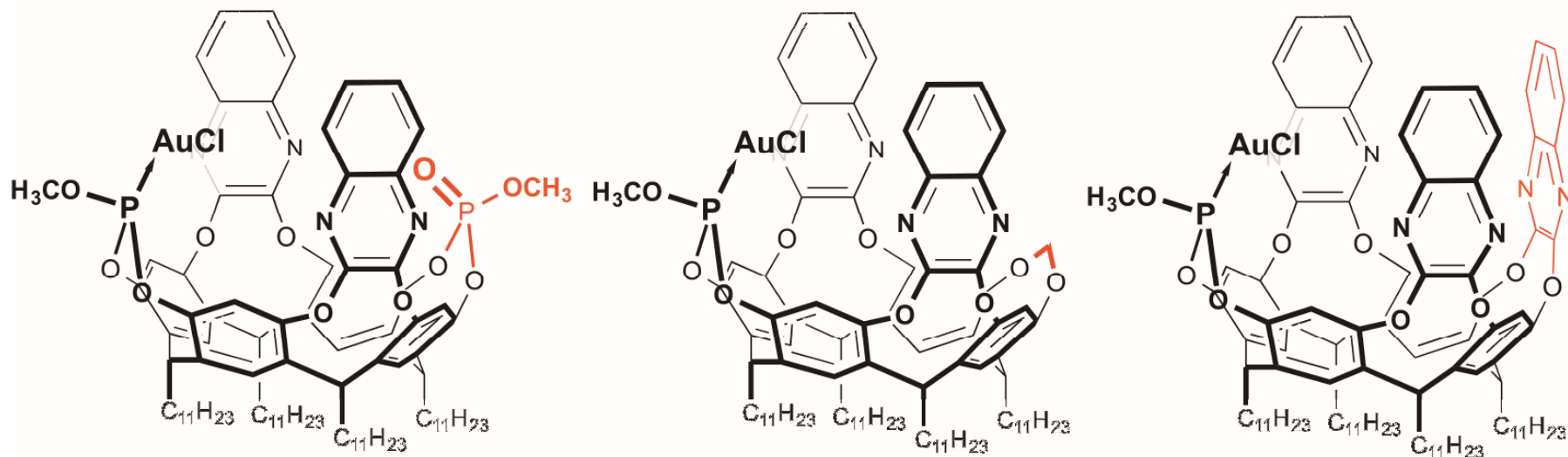
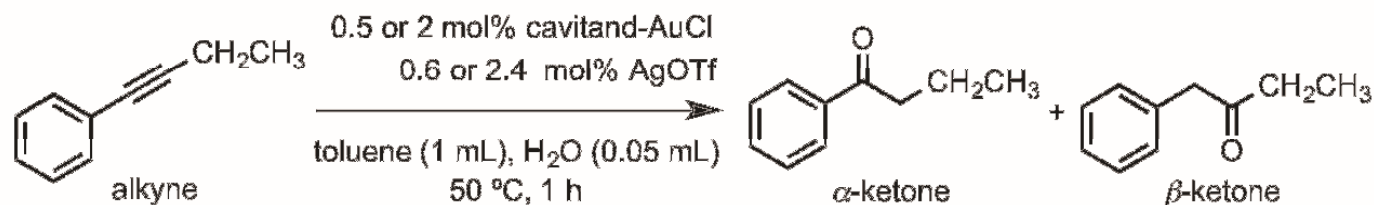
Aromatic rings would not be folded presumably due to oversized substructures.



These results enabled us to predict the ketones.



Effect of the covalently bonded P=O group; the group is indispensable for its smooth catalysis.



alkyne	0%
α -ketone	2%
β -ketone	88%

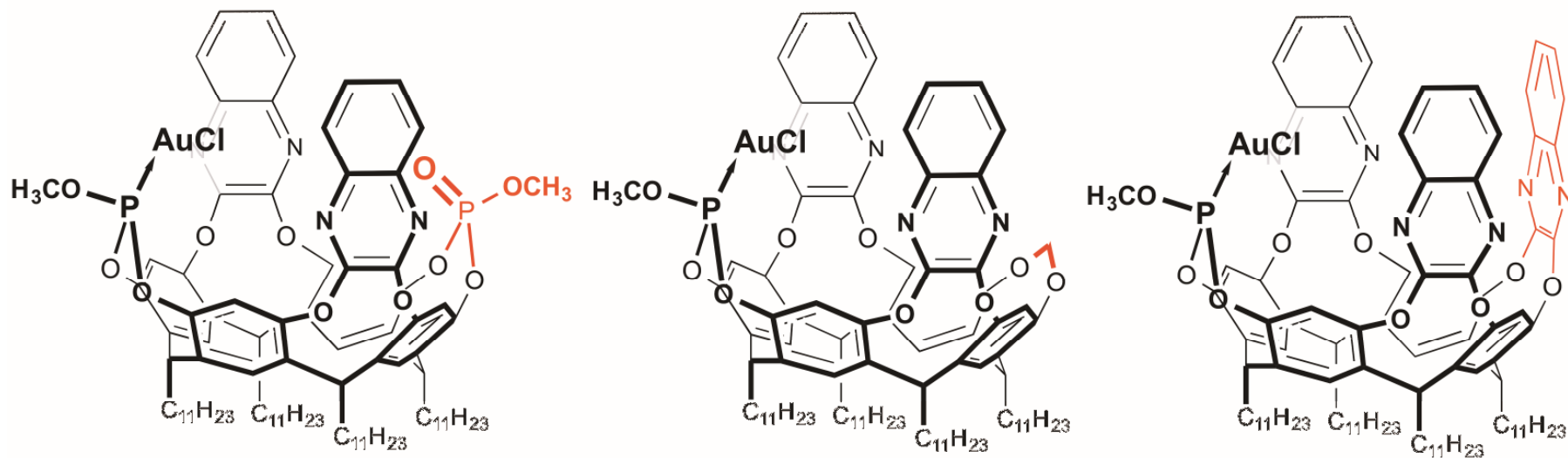
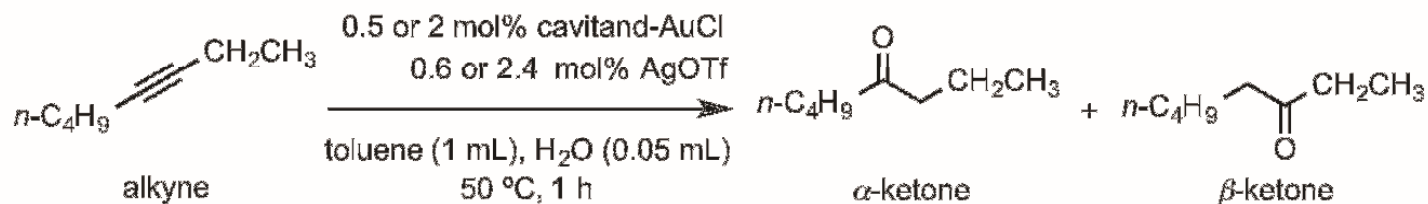
alkyne	100%
α -ketone	0%
β -ketone	0%

with O=PPh ₃	
1 h	14 h
71%	14%
1%	12%
1%	71%

alkyne	100%
α -ketone	0%
β -ketone	0%

with O=PPh ₃	
1 h	14 h
89%	43%
2%	7%
1%	38%

Even if the hydration occurred, the product distributions ended up in comparable ratios.

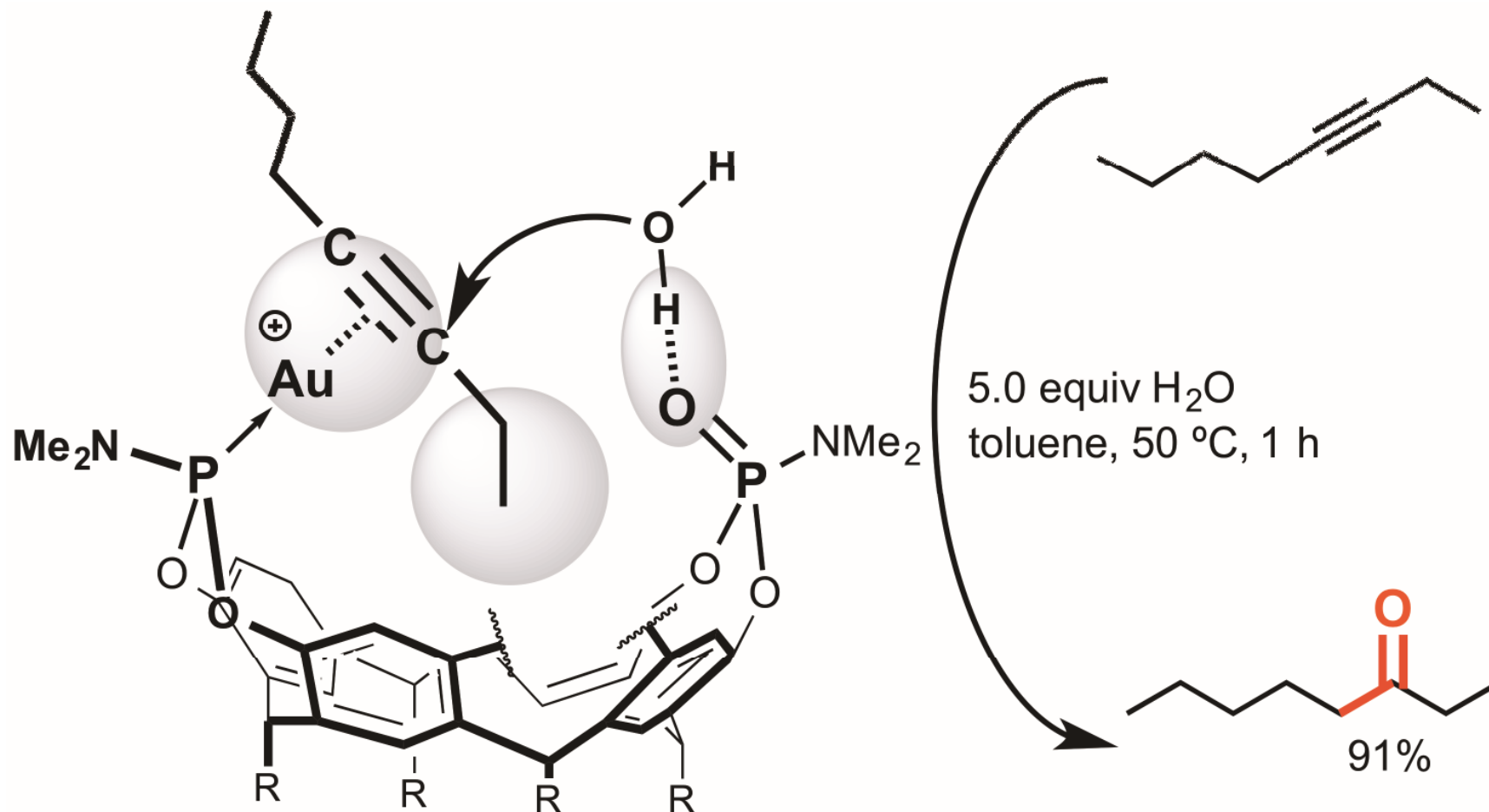


alkyne	0%
α -ketone	9%
β -ketone	91%

	with O=PPh ₃
alkyne	36%
α -ketone	33%
β -ketone	31%

	with O=PPh ₃
alkyne	3%
α -ketone	47%
β -ketone	50%

Summary



1. N. Endo, M. Inoue, T. Iwasawa, *Eur. J. Org. Chem.* **2018**, 1136-1140. (VIP)
2. M. Inoue, K. Ugawa, T. Maruyama, T. Iwasawa, *Eur. J. Org. Chem.* **2018**, 5304-5311. (VIP)