

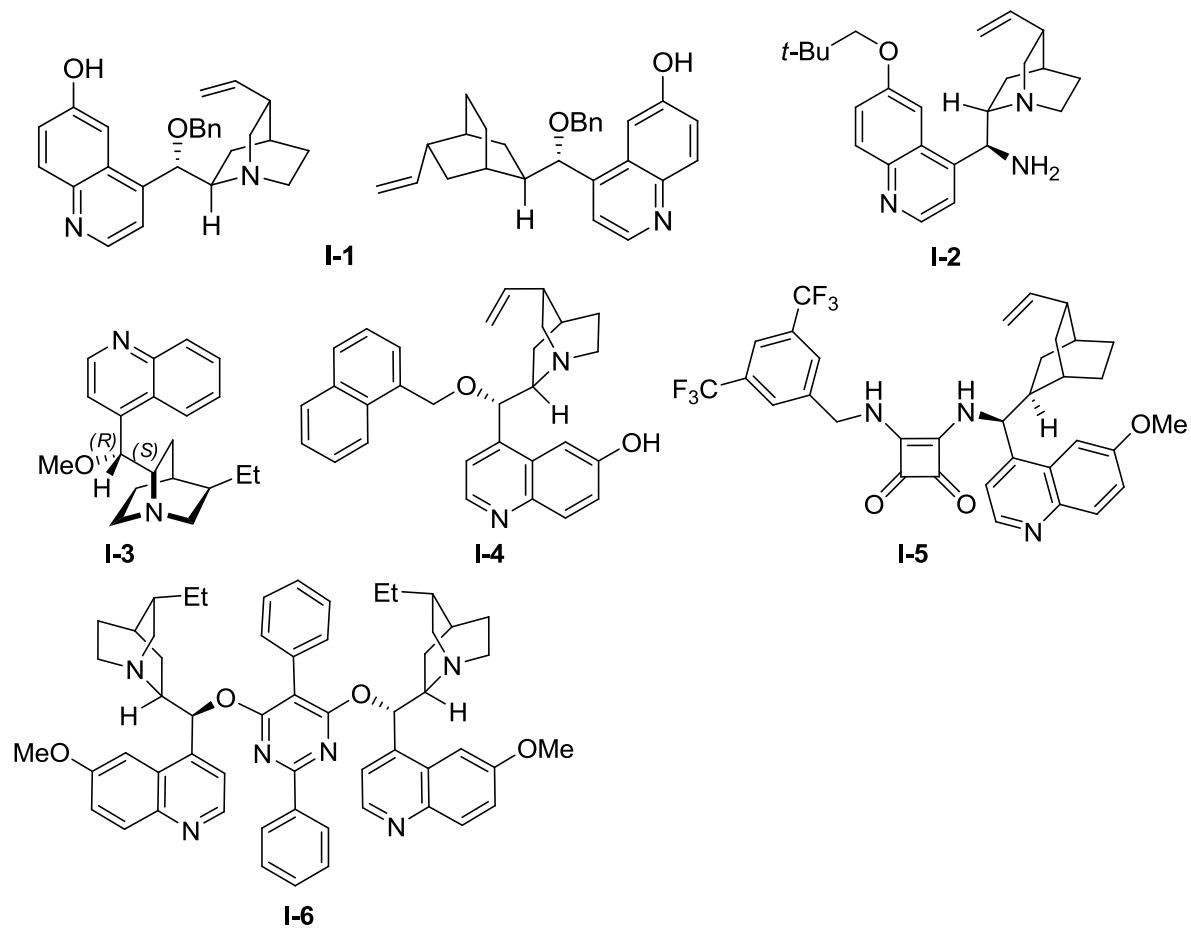
# Chemistry of $\alpha$ -Oxoesters; A Powerful Tool for Synthesis of Heterocycles

Bagher Eftekhari-Sis<sup>\*,†</sup> and Maryam Zirak<sup>‡</sup>

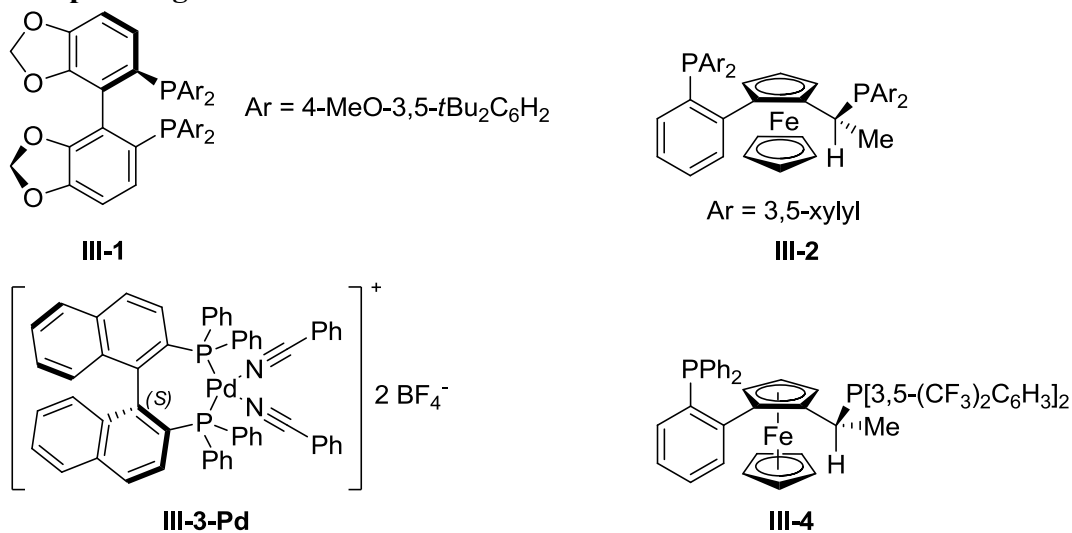
## Supporting Information

The structures of ligands, complexes and catalysts **I-XXI**:

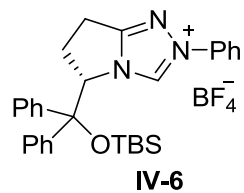
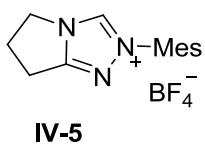
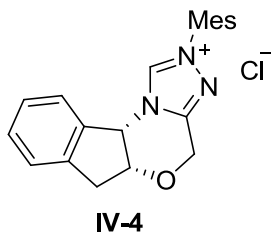
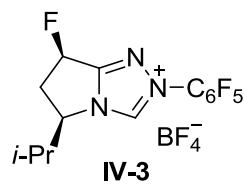
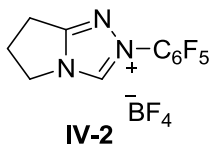
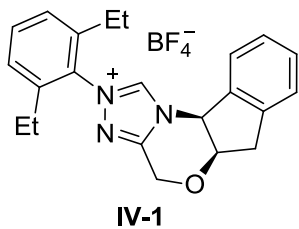
### Cinchona alkaloid derivatives **I**:



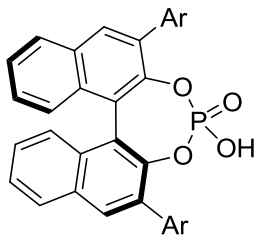
### Phosphine ligands **III**:



### Triazolium NHCs IV:



### Phosphoric acids and phosphoramidate V:

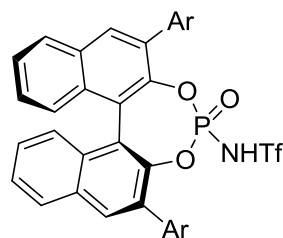


**V-1:** Ar = 2,4,6-*(i*-Pr)<sub>3</sub>C<sub>6</sub>H<sub>2</sub>

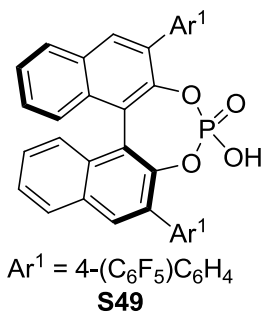
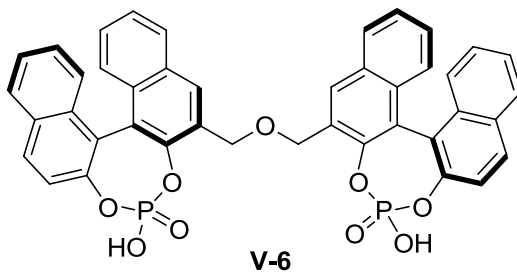
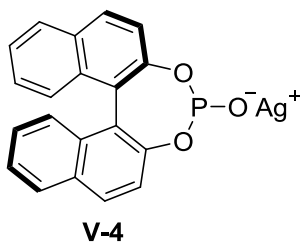
**V-3:** (*R*)-enantiomer; Ar = 9-phenanthrenyl

**V-5:** Ar = 9-anthracenyl

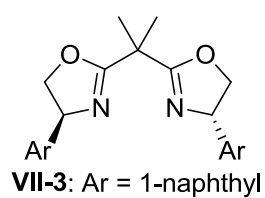
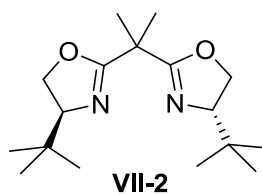
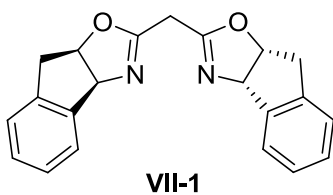
**V-7:** Ar<sup>1</sup> = 4-(C<sub>6</sub>F<sub>5</sub>)C<sub>6</sub>H<sub>4</sub>

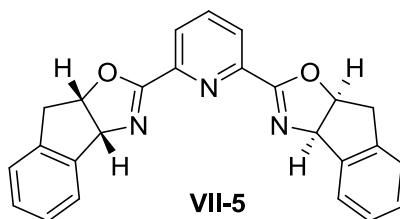
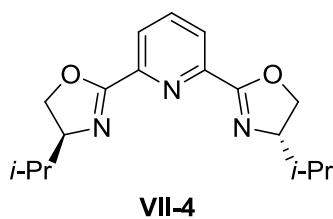
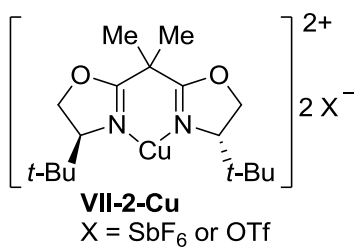


**V-2:** Ar = 2,4,6-*(i*Pr)<sub>3</sub>C<sub>6</sub>H<sub>2</sub>

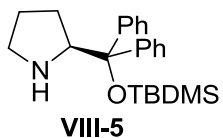
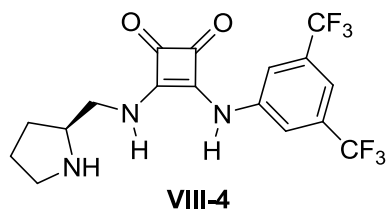
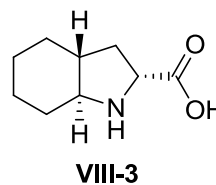
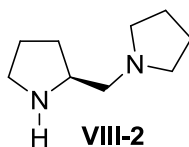
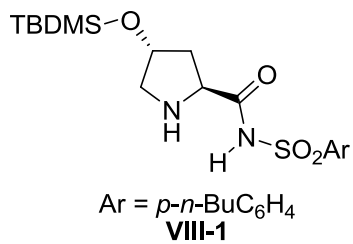


### Bis(oxazoline) ligands VII:

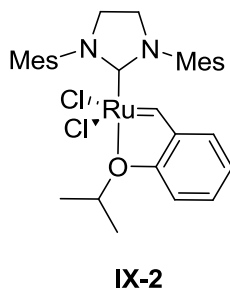
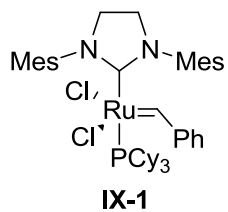




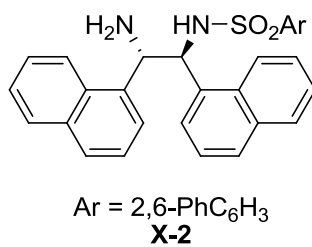
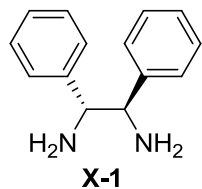
### Proline derivatives VIII:



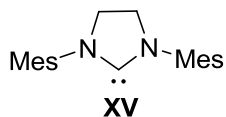
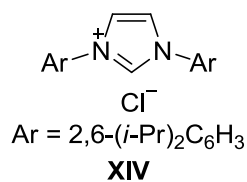
### Grubs Catalyst IX:



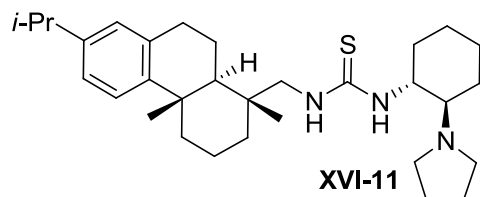
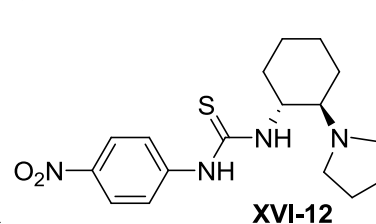
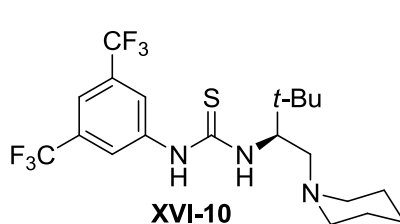
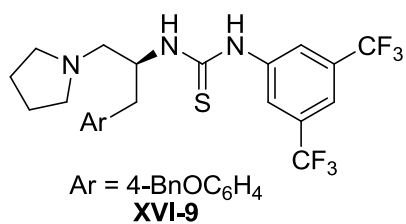
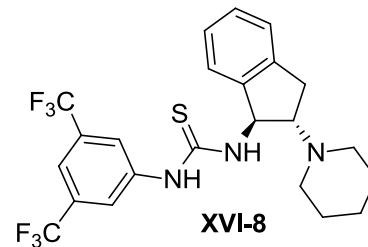
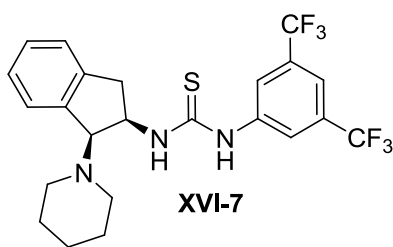
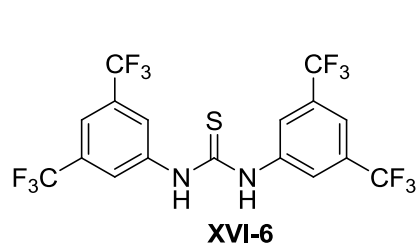
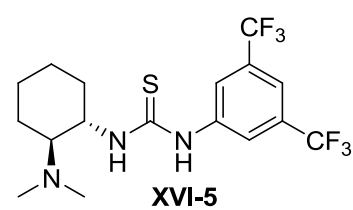
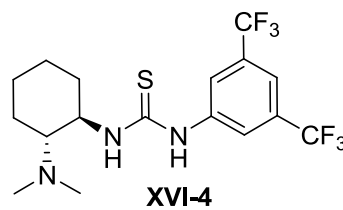
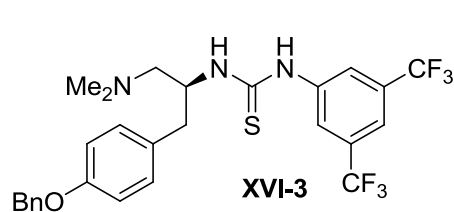
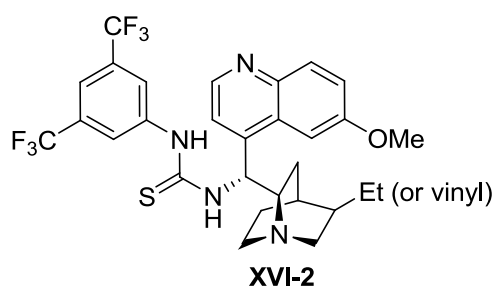
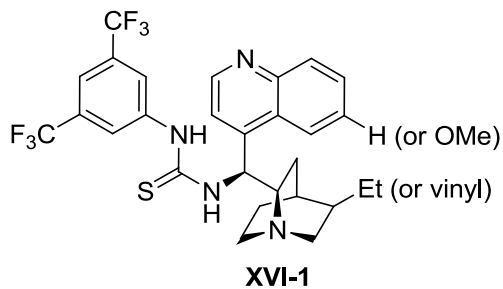
### Chiral Diamines X:



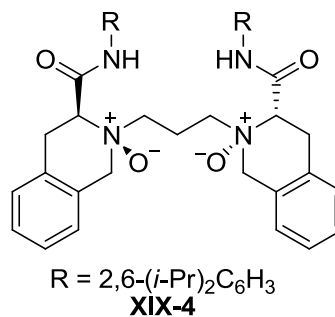
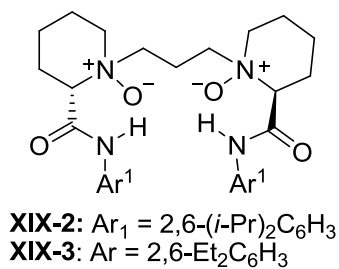
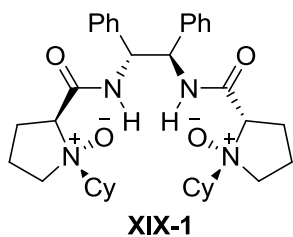
## NHCs XIV and XV:



## Thiourea Derivatives XVI:



***N,N'*-dioxides IXI:**



**Miscellaneous**

