Enantioselective [5+2] Annulations with a Cooperative Catalytic System

**Significance:** Synthetic chemists have long sought to combine N-heterocyclic carbene (NHC) organocatalysis and metal catalysis. However, because NHCs are excellent ligands for late-transition metals, the design of cooperative catalytic systems remains a formidable challenge (M. H. Wang, K. A. Scheidt Angew. Chem. Int. Ed. 2016, 55, 14912). Reported is the first highly enantioselective [5+2] annulation between an NHC enolate and a π-allyl palladium intermediate through a dual catalytic process.

**Comment:** The authors expand their previous studies on NHC/Pd-based catalytic systems (J. Am. Chem. Soc. 2016, 138, 7840; ibid. 2017, 139, 4443) by using a bidentate phosphine ligand to prevent NHC coordination to the active palladium catalyst. A matched combination of a chiral NHC and a chiral phosphine ligand promotes high levels of enantioselectivity, which has previously been a challenge for seven-membered rings due to both unfavorable entropy effects and transannular interactions (see, for example: Y.-N. Wang et al. Angew. Chem. Int. Ed. 2018, 57, 1596).

**Representative examples:**

\[
\begin{align*}
\text{Pd}_2\text{(dba)}_3 (2 \text{ mol\%}) & \quad \text{L (6 \text{ mol\%})} \\
\text{precatalyst 1 (10 \text{ mol\%})} & \quad \text{N-methylpiperidine (30 \text{ mol\%})} \\
\text{PhMe, r.t.} & \quad +
\end{align*}
\]

- 75% yield, >99% ee
- 30% yield, 99% ee
- 86% yield, >99% ee
- 82% yield, 92% ee
- 62% yield, 99% ee
- 79% yield, >99% ee
- 52% yield, >99% ee
- 67% yield, 99% ee

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