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Directed nucleophilic addition of phenoxides to cyclopropenes†

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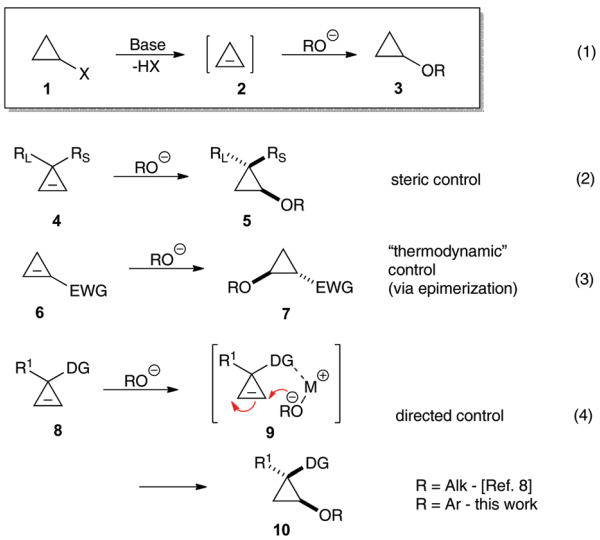
The alkali metal-templated addition of aryloxides across the double bond of non-conjugated cyclopropenes is described. High *cis*-selectivity is achieved through a directing effect of a strategically positioned carboxamide functionality.

Introduction

Ring-retentive metal-catalyzed additions to cyclopropenes *en route* to stereochemically defined cyclopropanes has evolved into a rapidly growing area during the past decade.[1,2] Non-catalytic ring-retentive diastereoselective additions of various nucleophilic entities across the double bond of cyclopropenes are much less common;[3] however, this unorthodox approach towards cyclopropyl-based scaffolds is very attractive from a synthetic standpoint. Nucleophilic additions of oxygen-based entities (alkoxides and phenoxides) to unsubstituted cyclopropene **2** (traditionally generated *in situ* from cyclopropylbromide **1**) are successfully utilized in medicinal chemistry and drug discovery for the installation of a cyclopropyloxy group into a pharmacophore (Scheme 1, eqn (1)).[4] Related transformations of highly strained symmetric spirocyclic polycyclopropanes are also known.[5] However, the reactions of substituted cyclopropenes are typically not diastereoselective,[6] unless the selectivity is enforced by excessive steric hindrance.[7] We have previously reported a formal nucleophilic substitution of bromocyclopropanes operating *via* the dehydrohalogenation/addition of *O*-based nucleophiles to cyclopropene intermediates, which can be carried out in both inter-[8] or intramolecular fashion.[9] Diastereoselectivity in these reactions is efficiently controlled by steric effects (Scheme 1, eqn (2)), *via* a thermodynamically driven epimerization of one of the newly formed centers (eqn (3)), or by a directing effect of a strategically placed functional group, capable of coordination to the alkali metal (eqn (4)).[8] A combination of the above-listed factors was also employed for the diastereoselective installation of several contiguous stereogenic centers.[10] While all these transformations are fairly general for alkoxides, aryloxides have been previously engaged only in the reactions with the most electrophilic cyclopropenes activated by a conjugate electron-withdrawing group (*i.e.* substrates of type **6**, Scheme 1, eqn (3)).[11] Herein we wish to disclose a diastereocontrolled addition of aryloxides to unactivated 3,3-disubstituted cyclopropenes **8** (eqn (4), R = Ar).



Scheme 1

Results and discussion

As mentioned above, superlative electrophilic properties render conjugate cyclopropenes of type **6** highly unstable.

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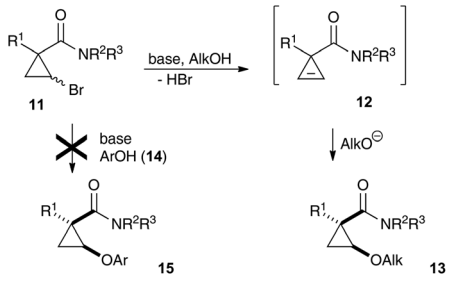
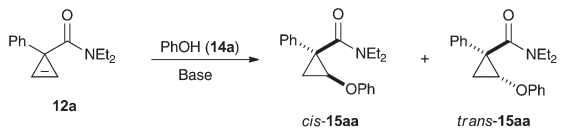
They, however, can be easily generated *in situ via* the 1,2-elimination of HBr from the corresponding α- or β-bromocyclopropanes.[11] Much more stable and isolable non-conjugated cyclopropenes **12** (R^1 = Me) can also be obtained *via* a base-assisted 1,2-dehydrobromination of bromocyclopropanes **11** (Scheme 2).[12] Both strained olefins **6** and **12** underwent directed nucleophilic additions of *in situ* generated alkoxides affording alkyl cyclopropyl ethers **7** and **13** with *trans*- and *cis*-configuration, respectively (Scheme 2).[8] However, an attempt to carry out the addition of phenols **14** starting from bromocyclopropane **11** failed to produce any cyclopropyl aryl ethers **15** and resulted in recovery of the starting material. The lack of reactivity was attributed to the lower pK_a's of phenols as compared to alcohols, which leads to reduced effective basicity of the media, rendering it insufficient for the dehydrobromination of **11** to take place. We rationalized that a stepwise approach involving a directed nucleophilic addition to pre-generated, isolable cyclopropene **12** could potentially be explored as an alternative route. In addition to the 1,2-dehydrobromination pathway, cyclopropenes **12** with an aryl substituent (R^1 = Ar) can also be accessed *via* the Rh(II)-catalyzed cyclopropenation of trimethylsilylacetylene.[13]



Scheme 2

To evaluate this idea, we subjected *N*,*N*-diethyl-1-phenyl-cycloprop-2-ene-1-carboxamide **12a** to a reaction with phenol **14a** (1.25 equiv.) in the presence of a base. Two conditions were probed, which previously proved best for the base-assisted additions of alkoxides[8,9] and nitrogen-based nucleophiles.[14] The first set of conditions employed a suspension of finely powdered KOH (1.50 equiv.) in anhydrous THF (Table 1, entry 1), and the second exploits a solution of *t*-BuOK (1.50 equiv.) in dry DMSO (entry 2). Test reactions carried out in the presence of these bases at room temperature resulted in recovery of the starting material. To force the reaction, the mixtures were heated to 70 °C (entries 3 and 4), which gave rise to trace amounts of aryl ether **15aa** in the reaction mediated by KOH (entry 3). Further increase of temperature to 90 °C and the use of a suspension of KOH in DMSO allowed for **15aa** in low yield as an equimolar mixture of two diastereomers (entry 5). Interestingly, the addition of 18-crown-6 ether to the mixture in order to improve the solubility of the base seemed to have suppressed the reaction (entry 6). Employment of THF as the

Table 1 Optimization of reaction conditions for directed nucleophilic additions of phenol to cyclopropene **12a**



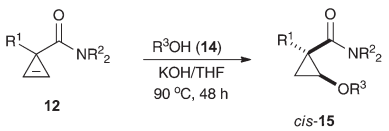
	Base (equiv.)	PhOH (equiv.)	Solvent	Temperature, °C	Time, h	Yield[a]	dr (*cis* : *trans*)[a]
1	KOH (1.50)	1.25	THF	RT	10	NR	N/A
2	*t*-BuOK (1.50)	1.25	DMSO	RT	10	NR	N/A
3	KOH (1.50)	1.25	THF	70	10	Trace	N/A
4	*t*-BuOK (1.50)	1.25	DMSO	70	10	NR	N/A
5	KOH (1.50)	1.25	DMSO	90	10	12	50 : 50
6	KOH (1.50)[b]	1.25	DMSO	90	10	NR	N/A
7	KOH (1.50)	1.25	THF	90	24	32	98 : 2
8	**KOH (3.50)**	**2.00**	**THF**	**90**	**48**	**58**	**97 : 3**
9	KOH (3.50)[b]	2.00	THF	90	48	12	50 : 50
10	$LiOH{\cdot}2H_2O$ (1.50)	1.25	THF	90	48	NR	N/A
11	$Ca(OH)_2$ (1.50)	1.25	THF	90	48	NR	N/A
12	NaOH (1.50)	1.25	THF	90	48	NR	N/A
13	DBU (1.50)	1.25	THF	90	48	NR	N/A
14	DBU/LiCl (1.50)	1.25	THF	90	48	NR	N/A
15	DBU/$FeCl_3$ (1.50)	1.25	THF	90	48	NR	N/A
16	DBU/$AgNO_3$ (1.50)	1.25	THF	90	48	NR	N/A
17	DBU/Ag_2O (1.50)	1.25	THF	90	48	NR	N/A
18	DBU/CuCl (1.50)	1.25	THF	90	48	NR	N/A
19	DBU/$CuCl_2$ (1.50)	1.25	THF	90	48	NR	N/A
20	**KOH (6.00)**	**4.00**	**THF**	**90**	**48**	**94**	**95 : 5**
21	Cs_2CO_3 (6.00)	4.00	THF	90	48	94	90 : 10

[a] Yields are determined by integration of ^{1}H NMR spectra of samples taken from crude reaction mixtures against dibromomethane as an internal standard. "NR" indicates that the formation of cyclopropyl aryl ether **15aa** was not detected, and the starting material **12a** remained intact. [b] These reactions were performed in the presence of stoichiometric amounts of 18-crown-6 ether.

reaction solvent proved more efficient and selective as compared to DMSO. Thus, heating cyclopropene **12a** in the presence of 1.25 equiv. of phenol (**14a**) and 1.50 equiv. of base for 24 h at 90 °C in THF afforded 32% of cyclopropyl aryl ether **15aa**. This reaction appeared to be highly diastereoselective, strongly favoring the formation of the *cis*-isomer (entry 7). Extending the reaction time to 48 h allowed for 58% conversion while maintaining nearly the same level of *cis*-selectivity (entry 8). Here again, the addition of 18-crown-6 had a detrimental effect on both the conversion and the facial selectivity (entry 9). It should be pointed out that the described transformation relies on sufficient Brønsted basicity of the employed base and on the coordinating ability (Lewis acidity) of the metal counter-cation, specifically, potassium hydroxide. Some less basic (but more Lewis acidic) hydroxides of lithium, sodium, and calcium gave no desired reactivity (entries 10–12).[15] We also unsuccessfully attempted to induce this reaction by using a strong organic base, such as DBU (entry 13); including its combinations with various Lewis-acidic metal ions (entries 14–19). Best conversions were achieved only in the presence of a large excess of phenoxide. Thus, a reaction of **12a** performed in the presence of 4 equiv. of phenol and 6 equiv. of KOH proceeded to completion affording the desired product **15aa** in nearly quantitative NMR yield and high diastereoselectivity (entry 20). Notably, an attempt to employ anhydrous cesium carbonate, which serves as a strong base, but has reduced coordination ability to the amide function, allowed for equally high product yield with lower diastereoselectivity (entry 21).

With optimized conditions in hand, we probed this reaction on a preparative scale. The post-reaction workup required additional optimization, as we discovered that the usual aqueous treatment and acid–base extraction led to notable decomposition of the product. It was found that neutralization of the reaction mixture with solid ammonium chloride allowed for precipitation of most inorganic salts at pH 8. These salts could be easily filtered off affording a clear filtrate which, after concentration in vacuum, was ready for chromatographic purification. This protocol allowed for the isolation of cyclopropyl aryl ether **15aa** in good yield (Table 2, entry 1). Next, we

Table 2 Directed nucleophilic additions of various phenols to cyclopropenes



12 *cis*-**15**

	12	R^1	$R^2{}_2$	14	R^3	15	Yield[a], %	dr[b]
1	**12a**	Ph	Et, Et	**14a**	Ph	**15aa**	81	95 : 5
2	**12a**	Ph	Et, Et	**14b**	4-$MeOC_6H_4$	**15ab**	78	96 : 4
3	**12a**	Ph	Et, Et	**14c**	4-*t*-BuC_6H_4	**15ac**	67	97 : 3
4	**12a**	Ph	Et, Et	**14d**	3-$MeOC_6H_4$	**15ad**	51	95 : 5
5	**12a**	Ph	Et, Et	**14e**	3-$Me_2NC_6H_4$	**15ae**	52	95 : 5
6	**12a**	Ph	Et, Et	**14f**	4-BrC_6H_4	**15af**	47	95 : 5
7	**12a**	Ph	Et, Et	**14g**	2-Naphthyl	**15ag**	59	95 : 5
8	**12a**	Ph	Et, Et	**14h**	4-$AcNHC_6H_4$	**15ah**	0	
9	**12a**	Ph	Et, Et	**14i**	4-NCC_6H_4	**15ai**	0	
10	**12b**	Ph	Me, Me	**14b**	4-$MeOC_6H_4$	**15bb**	55[c]	>98 : 2
11	**12c**	Ph	$-(CH_2)_4-$	**14a**	Ph	**15ca**	69	97 : 3
12	**12c**	Ph	$-(CH_2)_4-$	**14b**	4-$MeOC_6H_4$	**15cb**	78[c]	83 : 17
13	**12c**	Ph	$-(CH_2)_4-$	**14c**	4-*t*-BuC_6H_4	**15cc**	76	86 : 14
14	**12d**	Ph	$-(CH_2)_2O(CH_2)_2-$	**14a**	Ph	**15da**	53	95 : 5
15	**12d**	Ph	$-(CH_2)_2O(CH_2)_2-$	**14b**	4-$MeOC_6H_4$	**15db**	66[c]	>98 : 2
16	**12e**	Ph	$-(CH_2)_5-$	**14a**	Ph	**15ea**	33	88 : 12
17	**12f**	Ph	$-(CH_2)_2NEt(CH_2)_2-$	**14a**	Ph	**15fa**	0	
18	**12f**	Ph	$-(CH_2)_2NEt(CH_2)_2-$	**14b**	4-$MeOC_6H_4$	**15fb**	0	
19	**12g**	Ph	Bn, Bn	**14a**	Ph	**15ga**	0	
20	**12h**	Ph	*n*-Bu, H	**14a**	Ph	**15ha**	0	
21	**12i**	Ph	H, H	**14a**	Ph	**15ia**	0	
22	**12j**	4-FC_6H_4	Et, Et	**14a**	Ph	**15ja**	52	94 : 6
23	**12j**	4-FC_6H_4	Et, Et	**14b**	4-$MeOC_6H_4$	**15jb**	68	91 : 9
24	**12k**	4-FC_6H_4	$-(CH_2)_4-$	**14a**	Ph	**15ka**	60	92 : 8
25	**12k**	4-FC_6H_4	$-(CH_2)_4-$	**14b**	4-$MeOC_6H_4$	**15kb**	78[c]	>98 : 2
26	**12k**	4-FC_6H_4	$-(CH_2)_4-$	**14c**	4-*t*-BuC_6H_4	**15kc**	73[c]	>98 : 2
27	**12l**	3-FC_6H_4	Et, Et	**14a**	Ph	**15la**	50	92 : 8
28	**12l**	3-FC_6H_4	Et, Et	**14b**	4-$MeOC_6H_4$	**15lb**	71	94 : 6
29	**12m**	3-FC_6H_4	Me, Me	**14b**	4-$MeOC_6H_4$	**15mb**	64[c]	>98 : 2
30	**12n**	3-BrC_6H_4	Et, Et	**14b**	4-$MeOC_6H_4$	**15nb**	65	96 : 4

[a] Isolated yields of purified material (as a mixture of inseparable *cis*- and *trans*-diastereomers of **15**) are reported, unless specified otherwise. [b] In all examples, the *cis*/*trans* ratio is determined by GC or ^1H NMR spectroscopy of the crude reaction mixtures. [c] In these examples, the minor products *trans*-**15** were lost during chromatographic separation, and isolated yields are provided for diastereomerically pure *cis*-**15**.

explored the reactivity of different phenols in this directed addition. As expected, highly nucleophilic, electron-rich, non-bulky phenols bearing electron-donating groups in the *para*-position (**14b**,**c**) reacted smoothly providing high yields of the corresponding cyclopropyl aryl ethers **15ab** and **15ac**, respectively (entries 2 and 3). *meta*-Substituted aryloxides generated from phenols **14d**,**e** were less reactive due to less efficient localization of the negative charge (entries 4 and 5). Phenol **12f** possessing a weakly deactivating *para*-bromo substituent, as well as a sterically hindered 2-naphthol **12g** also proved less reactive (entries 6 and 7). Finally, *N*-(4-hydroxyphenyl)acetamide (**12h**) and *p*-cyanophenol **12i**, which allow for efficient stabilization of negative charge in the corresponding anions, did not provide any addition products at all (entries 8 and 9). We next moved on to investigate whether steric and electronic environments on the directing carboxamide functionality played any role in the reactivity of cyclopropenes. We reasoned that increased electron density on the carbonyl group would strengthen the coordination of the potassium cation, further enhancing the directing effect. On the other hand, steric hindrance as well as acidic hydrogens in secondary amides might impede the reaction. The observed reactivity was in line with the above rationale. Thus, cyclopropene **12b** derived from dimethylamine afforded a notably lower yield of the corresponding *p*-methoxyphenol adduct **15bb** (entry 10) as compared to a slightly more electron-rich diethylamine analog **12a** (entry 2). In contrast, the electron rich and non-bulky pyrrolidine derivative **12c** readily afforded the corresponding products **15ca**, **15cb**, and **15cc** (entries 11–13) in yields comparable to those obtained for diethylamine analogs.[16] More sterically hindered carboxamides derived from six-membered cyclic secondary amines such as morpholine (**12d**, entries 14 and 15), piperidine (**12e**, entry 16), and *N*-ethylpiperazine (**12f**, entries 17 and 18) showed attenuated reactivity. The latter did not react with even the most nucleophilic phenols (**14a**,**b**). Similarly, the sterically encumbered *N*,*N*-dibenzylamide **12g** proved to be inert under the standard reaction conditions (entry 19). We also failed to obtain adducts from the secondary and primary amides **12h** and **12i**, respectively. Starting materials in these reactions rapidly decomposed upon heating, potentially due to oligomerization involving a base-assisted attack of *N*-nucleophiles generated in the reaction mixture.[14] Finally, we found a negligible effect on the reactivity of the substituents in the aromatic ring alpha to the carboxamide functionality. All such cyclopropenes (**12j–12n**) provided the corresponding products in good yields (Table 2, entries 19–30). *cis*-Configuration of the obtained adducts was unambiguously confirmed by single crystal X-ray crystallography (**15cb** and **15db**, Fig. 1) or by a 2D-NOESY experiment (**15bb**, see the ESI† for details).

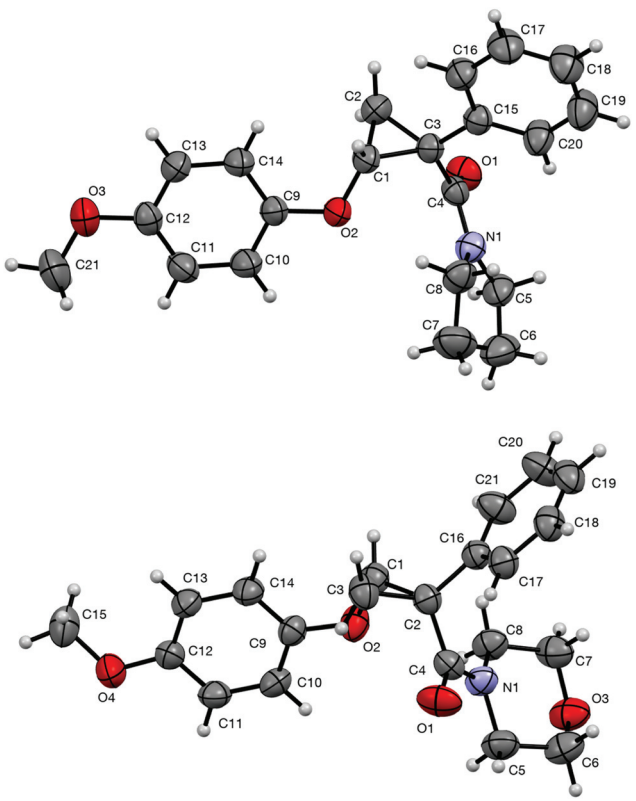


Fig. 1 ORTEP drawings of *cis*-**15cb** (CCDC 1571107,† top) and *cis*-**15db** (CCDC 1570793,† bottom) showing atom numbering labels and 50% probability amplitude displacement ellipsoids.

Conclusion

In conclusion, a strain-release driven, carboxamide-directed addition of aryloxides across the double bond of cyclopropenes providing diastereomerically pure cyclopropyl aryl ethers was demonstrated. The facial selectivity of this transformation is controlled by strong coordination of the amide functionality to the potassium cation, which served as an efficient delivery vehicle for the aryloxide nucleophile.

Experimental part

NMR spectra were recorded on a Bruker Avance DRX-500 (500 MHz) with a dual carbon/proton cryoprobe (CPDUL), Bruker III (600 MHz) equipped with a BBO probe. ^{13}C NMR spectra were registered with broadband decoupling. The (+) and (−) designations represent positive and negative intensities of signals in ^{13}C DEPT-135 experiments. IR spectra were recorded on a ThermoFisher Nicolet™ iS™ 5 FT-IR spectrometer. HRMS was carried out on an LCT Premier (Micromass Technologies) instrument employing ESI TOF detection techniques. Glassware used in moisture-free syntheses was flame-dried in vacuum prior to use. Column chromatography was carried out on silica gel (Sorbent Technologies, 40–63 mm). Pre-coated silica gel plates (Sorbent Technologies Silica XG 200 mm) were used for TLC analyses. Anhydrous dichloromethane was obtained by passing degassed commercially available HPLC-grade inhibitor-free solvent consecutively

through two columns filled with activated alumina and stored over molecular sieves under nitrogen. Water was purified by dual stage deionization followed by dual stage reverse osmosis. Cyclopropenes **12a,c–i** were synthesized according to our previously published procedure[13b] and had physical and spectral properties identical to those earlier reported. The syntheses of cyclopropenes **12b,j–n** are described below. All other reagents and solvents were purchased from commercial vendors and used as received.

1-(3-Fluorophenyl)cycloprop-2-ene-1-carboxylic acid

Methyl (3-fluorophenyl)acetate (5.86 g, 34.8 mmol, 1.00 equiv.) and tosyl azide (7.2 g, 36.5 mmol, 1.05 equiv.) were stirred in acetonitrile (100 mL) at 0 °C, and DBU (6.32 g, 41.5 mmol, 1.2 equiv.) was added dropwise. Upon complete addition the reaction was allowed to warm to room temperature and was stirred overnight. The solvent was then evaporated and the residue was partitioned between saturated ammonium chloride and methylene chloride. The aqueous phase was then extracted with methylene chloride (3 × 30 mL). Combined organic phases were then washed with brine, dried with $MgSO_4$, filtered, and concentrated. The recovered material was then immediately filtered through a short pad of Silica gel using a 9 : 1 mixture of hexane and ethyl acetate. Crude methyl 2-diazo-2-(3-fluorophenyl)acetate was obtained as a red oil. This material was then dissolved in trimethylsilylacetylene (2.5 mL) (insoluble impurities could be ignored and filtered off using a cotton plug), and added *via* a syringe pump over 18 h to a stirring and refluxing suspension of rhodium(II) acetate dimer (2.3 mg, 5.1 μmol, 0.015 mol%) in trimethylsilylacetylene (49 mL, 348 mmol, 10.0 equiv.). After complete addition, the reaction was monitored by gas chromatography until complete consumption of the starting material was observed. Once this was achieved, the reflux condenser was replaced with a distillation head and most of the trimethylsilylacetylene was recovered by distillation at ambient pressure. The residual solvent was then removed under vacuum. The reaction mixture was then purified by short column chromatography eluting with a mixture of hexane : CH_2Cl_2 (3 : 1). Crude ethyl 1-(3-fluorophenyl)-2-(trimethylsilyl)cycloprop-2-ene-1-carboxylate was obtained as a yellowish oil, which was stirred at 0 °C in a mixture of methanol and THF (1 : 1, 50 mL). An aqueous solution of sodium hydroxide (1.5 M, 15 mL) was added dropwise and the mixture was stirred for 18 h. Organic solvents were then removed under vacuum and the remaining aqueous solution was washed with dichloromethane (20 mL). The mixture was acidified to pH 2 with 1 N aqueous HCl and extracted with dichloromethane (3 × 10 mL). The combined organic phases were washed with brine, dried with $MgSO_4$, filtered, and concentrated. The obtained product was purified by column chromatography on silica gel eluting with a mixture of hexane/EtOAc (2 : 1). The title compound was obtained as a colorless crystalline solid, mp 82.0–83.0 °C, R_f 0.33. Overall yield 3.212 g (18.0 mmol, 52%). ^{1}H NMR (500 MHz, chloroform-*d*) δ 7.32–7.26 (m, 1H), 7.21 (s, 2H), 7.09 (ddd, J = 7.7, 1.7, 1.0 Hz, 1H), 7.05 (ddd, J = 10.1, 2.6, 1.6 Hz, 1H), 6.95 (tdd, J = 8.4, 2.6, 1.0 Hz, 1H). ^{13}C NMR (126 MHz, chloroform-*d*) δ 180.9, 162.6 (d, J = 245.3 Hz), 143.1 (d, J = 7.3 Hz), 129.6 (d, J = 8.2 Hz), 123.9 (d, J = 2.8 Hz), 115.4 (d, J = 22.0 Hz), 113.8 (d, J = 21.0 Hz), 106.6, 29.9 (d, J = 2.3 Hz). FT IR (NaCl, cm^{-1}): 3026, 3007, 1643, 1495, 1435, 1400, 1350, 1215, 1097, 1030, 995, 777, 754, 689. HRMS (TOF ES): found 177.0351, calculated for $C_{10}H_6FO_2$ (M − H)$^-$ 177.0357 (3.4 ppm).

1-(4-Fluorophenyl)cycloprop-2-ene-1-carboxylic acid

Typical procedure: A solution of methyl 1-(4-fluorophenyl)-2-(trimethylsilyl)cycloprop-2-ene-1-carboxylate[13a] (457 mg, 1.73 mmol, 1.0 equiv.) in a mixture of methanol and THF (1 : 1, 20 mL) was stirred. An aqueous solution of sodium hydroxide (1.5 M, 15 mL) was added dropwise and the mixture was stirred for 18 h. Organic solvents were then removed under vacuum and the remaining aqueous solution was washed with dichloromethane (20 mL). The mixture was acidified to pH 2 with 1 N aqueous HCl and extracted with dichloromethane (3 × 10 mL). The combined organic phases were washed with brine, dried with $MgSO_4$, filtered, and concentrated. The obtained product is typically pure enough to be used in further amide coupling as is; however, if necessary, further purification can be achieved by column chromatography on silica gel eluting with a mixture of hexane/EtOAc (1 : 1). The title compound was obtained as a colorless solid, mp 102.0–103.4 °C, R_f 0.40. Yield 289 mg (1.66 mmol, 96%). ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.29–7.23 (m, 2H), 7.21 (s, 2H), 7.03–6.95 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 181.3, 161.8 (d, J = 245.6 Hz), 136.5 (d, J = 3.2 Hz), 130.1 (+, d, J = 8.2 Hz, 2C), 115.1 (+, d, J = 21.5 Hz, 2C), 107.2 (+, 2C), 29.7; FT IR (KBr, cm^{-1}): 3155, 3114, 3072, 2972, 2846, 2619, 1693, 1650, 1604, 1512, 1427, 1317, 1222, 1161, 1108, 983, 933, 813, 752; HRMS (TOF ES): HRMS (TOF ES): found 177.0343, calculated for $C_{10}H_6FO_2$ (M − H)$^-$ 177.0352 (5.1 ppm).

1-(3-Bromophenyl)cycloprop-2-ene-1-carboxylic acid

This compound was obtained by the hydrolysis of 1-(3-bromophenyl)-2-(trimethylsilyl)cycloprop-2-ene-1-carboxylate[9c] (6.90 g, 21.2 mmol) using the protocol described for the synthesis of 1-(4-fluorophenyl)cycloprop-2-ene-1-carboxylic acid (*vide supra*). The title compound was obtained as a colorless crystalline solid, mp 88.4–89.7 °C, R_f 0.33 (hexanes/EtOAc 2 : 1). Yield 3.897 g (16.3 mmol, 77%). ^{1}H NMR (500 MHz, chloroform-d) δ 7.43 (t, J = 1.8 Hz, 1H), 7.36 (ddd, J = 7.8, 2.0, 1.1 Hz, 1H), 7.24 (ddd, J = 7.8, 1.8, 1.2 Hz, 1H), 7.20 (s, 2H), 7.17 (t, J = 7.8 Hz, 1H); ^{13}C NMR (126 MHz, chloroform-d) δ 180.6, 142.9, 131.5 (+), 129.9 (+), 129.7 (+), 127.1 (+), 122.2, 106.8, 29.8; FT IR (NaCl, cm^{-1}): 3120, 2981, 1697, 1660, 1594, 1564, 1412, 1267, 1227, 985, 884, 783, 703, 605; HRMS (TOF ES): found 236.9551, calculated for $C_{10}H_6BrO_2$ (M−) 236.9557 (2.5 ppm).

1-(3-Fluorophenyl)-*N*,*N*-dimethylcycloprop-2-ene-1-carboxamide (12m) (typical procedure A)

A flame-dried round bottom 25 mL flask was charged with 1-(3-fluorophenyl)cycloprop-2-ene-1-carboxylic acid (375 mg,

2.11 mmol, 1.00 equiv.), DMF (1 drop) and freshly distilled anhydrous dichloromethane (15 ml) under nitrogen atmosphere. Oxalyl chloride (271 μL, 401 mg, 3.16 mmol, 1.50 equiv.) was then added dropwise and the mixture was stirred at room temperature for 2 h. The solution was concentrated under reduced pressure to provide a pale yellow solid residue, which was dissolved in anhydrous dichloromethane (5.0 mL) and added dropwise to a solution of dimethylamine (40% water solution) (528 μL, 474 mg, 4.21 mmol, 2.00 equiv.) and triethylamine (608 μL, 426 mg, 4.21 mmol, 2.00 equiv.) in dichloromethane (10.0 mL). The reaction mixture was stirred for 18 hours at RT and then partitioned between water and dichloromethane. The aqueous phase was acidified with 1 N HCl to pH 2. The organic phase was then extracted with acidified water (pH 2, 3 × 10 mL). The combined aqueous layers were back-extracted once with dichloromethane, which was combined with other organic phases, washed with brine, dried with $MgSO_4$, filtered, and concentrated. The product was purified by column chromatography on silica gel to afford the title compound as a colorless crystalline solid, mp 109.2–109.3 °C, R_f 0.16 (hexanes/EtOAc 1 : 1). Yield 346 mg (1.67 mmol, 80%). ^{1}H NMR (500 MHz, chloroform-*d*) δ 7.30–7.22 (m, 2H), 7.21 (s, 2H), 6.92–6.86 (m, 2H), 6.79 (m, 1H), 2.99 (s, 3H), 2.91 (s, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 173.2, 163.1 (d, J = 246.1 Hz), 146.2 (d, J = 6.5 Hz), 130.0 (d, J = 8.9 Hz) (+), 121.5 (d, J = 2.7 Hz) (+), 113.2 (d, J = 21.0 Hz) (+), 112.7 (d, J = 21.9 Hz) (+), 108.8 (+), 37.40 (+), 35.1 (+), 31.6 (d, J = 2.5 Hz); FT IR (NaCl, cm^{-1}): 3119, 3076, 2931, 1645, 1623, 1584, 1486, 1398, 1265, 1116, 1026, 859, 787, 695, 657, 609; HRMS (TOF ES): found 228.0809, calculated for $C_{12}H_{12}FNONa$ (M + Na) 228.0801 (3.5 ppm).

N,*N*-Dimethyl-1-phenylcycloprop-2-ene-1-carboxamide (12b)

The compound was prepared according to the typical procedure A, employing 1-phenylcycloprop-2-ene-1-carboxylic acid (500 mg, 3.12 mmol, 1.0 equiv.) and dimethylamine (40% solution in water, 704 mg, 6.24 mmol, 2.0 equiv.). The reaction was carried out at r.t. for 18 h followed by preparative column chromatography on silica gel to afford the title compound as a colorless crystalline solid, mp 151.0–151.3 °C, R_f 0.22 (hexanes/EtOAc 1 : 1). Yield 325 mg (1.76 mmol, 57%). ^{1}H NMR (500 MHz, chloroform-*d*) δ 7.32–7.27 (m, 2H), 7.23 (s, 2H), 7.22–7.17 (m, 1H), 7.13–7.11 (m, 1H), 7.11–7.09 (m, 1H), 2.98 (s, 3H), 2.90 (s, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 173.9, 143.2, 128.4 (+), 126.2 (+), 125.8 (+), 109.1 (+), 37.4 (+), 35.1 (+), 31.9; FT IR (NaCl, cm^{-1}): 3118, 3077, 3020, 2925, 1644, 1624, 1494, 1445, 1397, 1266, 1397, 1195, 1029, 741, 655, 606; HRMS (TOF ES): found 210.0898, calculated for $C_{12}H_{13}NONa$ (M + Na) 210.0895 (1.4 ppm).

N,*N*-Diethyl-1-(4-fluorophenyl)cycloprop-2-ene-1-carboxamide (12j)

The compound was prepared according to the typical procedure A, employing 1-(4-fluorophenyl)cycloprop-2-ene-1-carboxylic acid (223 mg, 1.28 mmol, 1.0 equiv.) and diethylamine (323 μl, 228 mg, 3.12 mmol, 2.0 equiv.) The reaction was carried out at RT for 18 h followed by preparative column chromatography on silica gel to afford the title compound as a colorless solid, mp 86.7–88.7 °C, R_f 0.23. Yield 232 mg (0.099 mmol, 78%). ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.25 (s, 2H), 7.12–7.05 (m, 2H), 6.99–6.93 (m, 2H), 3.38 (q, J = 7.1 Hz, 2H), 3.30 (q, J = 7.1 Hz, 2H), 1.14 (t, J = 7.1 Hz, 3H), 0.89 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$): δ 173.0, 161.6 (d, J = 244.9 Hz), 139.4 (d, J = 3.1 Hz), 127.6 (+, d, J = 8.1 Hz, 2C), 115.3 (+, d, J = 21.5 Hz, 2C), 109.9 (+, 2C), 41.9 (–), 39.1 (–), 31.6, 13.8 (+), 12.7 (+); FT IR (KBr, cm^{-1}): 3070, 2975, 2935, 2875, 1620, 1508, 1460, 1429, 1380, 1363, 1313, 1276, 1220, 1159, 1120, 1097, 1012, 825, 810; HRMS (TOF ES): HRMS (TOF ES): found 256.1121, calculated for $C_{14}H_{16}FNONa$ (M + Na) 256.1114 (2.7 ppm).

(1-(4-Fluorophenyl)cycloprop-2-en-1-yl)(pyrrolidin-1-yl) methanone (12k)

The compound was prepared according to the typical procedure A, employing 1-(4-fluorophenyl)cycloprop-2-ene-1-carboxylic acid[13b] (750 mg, 4.21 mmol, 1.0 equiv.) and pyrrolidine (599 mg, 8.42 mmol, 2.0 equiv.). The reaction was carried out at r.t. for 18 h followed by preparative column chromatography on silica gel to afford the title compound as a colorless crystalline solid, mp 154.7–155.0 °C, R_f 0.18 (hexanes/EtOAc 1 : 1). Yield 845 mg (3.65 mmol, 87%). ^{1}H NMR (500 MHz, chloroform-*d*) δ 7.27 (s, 2H), 7.10 (dd, J = 8.6, 5.3 Hz, 2H), 6.97 (t, J = 8.6 Hz, 2H), 3.51 (t, J = 6.6 Hz, 2H), 3.21 (t, J = 6.4 Hz, 2H), 1.91–1.69 (m, 4H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 172.1, 161.5 (d, J = 245.1 Hz), 138.7 (d, J = 2.8 Hz), 127.6 (+), 115.2 (d, J = 21.7 Hz) (+), 109.5 (+), 46.4 (–), 45.8 (–), 32.3, 26.1 (–), 24.1 (–); FT IR (NaCl, cm^{-1}): 3101, 3059, 2973, 2876, 1617, 1507, 1440, 1235, 824, 669, 563; HRMS (TOF ES): found 254.0958, calculated for $C_{14}H_{14}FNONa$ (M + Na) 254.0957 (0.4 ppm).

N,*N*-Diethyl-1-(3-fluorophenyl)cycloprop-2-ene-1-carboxamide (12l)

The compound was prepared according to the typical procedure A, employing 1-(3-fluorophenyl)cycloprop-2-ene-1-carboxylic acid (375 mg, 2.11 mmol, 1.00 equiv.) and diethylamine (308 mg, 4.21 mmol, 2.00 equiv.). The reaction was carried out at RT for 18 h followed by preparative column chromatography on silica gel to afford the title compound as a colorless crystalline solid, mp 78.8–79.0 °C, R_f 0.26 (hexanes/EtOAc 1 : 1). Yield 383 mg (1.64 mmol, 78%). ^{1}H NMR (500 MHz, chloroform-*d*) δ 7.22–7.14 (m, 2H), 7.17 (s, 1H), 6.89–6.84 (m, 1H), 6.82 (tdd, J = 8.4, 2.5, 0.9 Hz, 1H), 6.74 (dt, J = 10.2, 1.9 Hz, 1H), 3.34 (q, J = 7.1 Hz, 2H), 3.26 (q, J = 7.1 Hz, 2H), 1.11 (dd, J = 7.5, 6.7 Hz, 3H), 0.88 (dd, J = 7.5, 6.7 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 172.5, 163.1 (d, J = 246.1 Hz), 146.6 (d, J = 6.4 Hz), 129.9 (d, J = 8.2 Hz) (+), 121.6 (d, J = 2.7 Hz) (+), 113.2 (d, J = 21.0 Hz) (+), 112.8 (d, J = 21.9 Hz) (+), 109.5 (+), 41.9 (–), 39.0 (–), 31.8, 13.8 (+), 12.6 (+); FT IR (NaCl, cm^{-1}): 3067, 2979, 2937, 1614, 1583, 1481, 1430, 1265, 1028, 649, 596; HRMS (TOF ES): found 256.1115, calculated for $C_{12}H_{16}FNONa$ (M + Na) 256.1114 (0.4 ppm).

1-(3-Bromophenyl)-*N*,*N*-diethylcycloprop-2-ene-1-carboxamide (12n)

The compound was prepared according to the typical procedure A, employing 1-(3-bromophenyl)cycloprop-2-ene-1-carboxylic acid (375 mg, 1.57 mmol, 1.00 equiv.) and diethylamine (229 mg, 3.14 mmol, 2.0 equiv.). The reaction was carried out at RT for 18 h followed by preparative column chromatography on silica gel to afford the title compound as a colorless crystalline solid, mp 102.2–102.5 °C, R_f 0.23 (hexanes/EtOAc 1 : 1). Yield 356 mg (1.21 mmol, 77%). ^{1}H NMR (500 MHz, chloroform-*d*) δ 7.37–7.28 (m, 1H), 7.24 (s, 2H), 7.23 (s, 1H), 7.15 (t, J = 7.8 Hz, 1H), 7.11–7.06 (m, 1H), 3.40 (q, J = 7.1 Hz, 2H), 3.31 (q, J = 7.1 Hz, 2H), 1.17 (t, J = 7.1 Hz, 3H), 0.94 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 172.4, 146.1, 129.9 (+), 129.4 (+), 129.0 (+), 124.8 (+), 122.7, 109.3 (+), 41.88 (−), 39.0(−), 31.8, 13.8 (+), 12.6 (+); FT IR (NaCl, cm^{-1}): 3108, 3063, 2977, 2935, 1617, 1471, 1314, 1284, 1218, 889, 781, 709, 690, 681; HRMS (TOF ES): found 316.0316, calculated for $C_{12}H_{16}BrNONa$ (M + Na) 316.0313 (0.9 ppm).

***N*,*N*-Diethyl-2-phenoxy-1-phenylcyclopropane-1-carboxamide (15aa) (typical procedure B)**

A 1 mL vial was charged with *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.), phenol (**14a**) (87 mg, 0.929 mmol, 4.00 equiv.), KOH (78 mg, 1.393 mmol, 6.00 equiv.) and freshly distilled THF (800 μL). The mixture was stirred at 90 °C for 48 h. Then, the reaction mixture was cooled down to RT and quenched with solid ammonium chloride (150 mg). When pH of the reaction mixtures dropped down to 8, inorganic salts were filtered off using a silica plug; the filtrate was concentrated under reduced pressure and fractioned using column chromatography on silica gel to afford the title compound as a colorless oil, R_f 0.21 (hexanes/EtOAc 5 : 1). Yield 58 mg (0.187 mmol, 81%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.41–7.20 (m, 7H), 7.05–6.94 (m, 3H), 4.55 (dd, J = 6.1, 4.0 Hz, 1H), 3.71–3.48 (m, 2H), 3.34–3.21 (m, 2H), 1.96 (dd, J = 6.3, 4.0 Hz, 1H), 1.27 (t, J = 6.2 Hz, 1H), 1.17 (t, J = 7.0 Hz, 3H), 0.75 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.8, 158.3, 139.5, 129.5 (+), 129.0 (+), 127.0 (+), 126.2 (+), 121.6 (+), 115.3 (+), 58.5 (+), 41.6 (−), 39.4 (−), 36.7, 23.8 (−), 13.0 (+), 12.4 (+); FT IR (NaCl, cm^{-1}): 3061, 2974, 2935, 2874, 1637, 1598, 1494, 1458, 1247, 754, 693; HRMS (TOF ES): found 332.1624, calculated for $C_{20}H_{23}NO_2Na$ (M + Na) 332.1626 (0.6 ppm).

***N*,*N*-Diethyl-2-(4-methoxyphenoxy)-1-phenylcyclopropane-1-carboxamide (15ab)**

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (115 mg, 0.929 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 23 : 1), colorless oil, R_f 0.19 (hexanes/EtOAc 5 : 1). Yield 61.1 mg (0.18 mmol, 78%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.37–7.28 (m, 2H), 7.28–7.20 (m, 3H), 6.97–6.88 (m, 2H), 6.86–6.80 (m, 2H), 4.50 (dd, J = 6.1, 4.0 Hz, 1H), 3.77 (s, 3H), 3.66–3.49 (m, 2H), 3.33–3.20 (m, 2H), 1.94 (dd, J = 6.2, 3.9 Hz, 1H), 1.23 (t, J = 6.2 Hz, 1H), 1.16 (t, J = 7.1 Hz, 3H), 0.74 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.8, 154.4, 152.2, 139.5, 128.9 (+), 126.8 (+), 126.0 (+), 116.1 (+), 114.6 (+), 58.9 (+), 55.7 (+), 41.5 (−), 39.3 (−), 36.6, 23.6 (−), 12.9 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2973, 2935, 2834, 1637, 1507, 1462, 1430, 1239, 1215, 1034, 826, 752, 700, 520; HRMS (TOF ES): found 340.1914, calculated for $C_{21}H_{26}NO_3$ (M + H) 340.1913 (0.3 ppm).

2-(4-(*tert*-Butyl)phenoxy)-*N*,*N*-diethyl-1-phenylcyclopropane-1-carboxamide (15ac)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.) and 4-(*tert*-butyl)phenol (**14c**) (140 mg, 0.929 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 33 : 1), colorless oil, R_f 0.25 (hexanes/EtOAc 3 : 1). Yield 57 mg (0.156 mmol, 67%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.37–7.28 (m, 4H), 7.27–7.21 (m, 3H), 6.97–6.91 (m, 2H), 4.52 (dd, J = 6.1, 4.0 Hz, 1H), 3.68–3.48 (m, 2H), 3.34–3.20 (m, 2H), 1.95 (dd, J = 6.3, 4.0 Hz, 1H), 1.30 (s, 9H), 1.28–1.23 (m, 1H), 1.17 (t, J = 7.0 Hz, 3H), 0.75 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.7, 155.9, 144.2, 139.5, 128.9 (+), 126.81 (+), 126.2 (+), 126.0 (+), 114.6 (+), 58.5 (+), 41.5 (−), 39.3 (−), 36.5, 34.1 (+), 31.5 (+), 23.7 (−), 12.9 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2964, 2871, 1640, 1512, 1429, 1461, 1249, 1182, 1146, 829, 759, 699; HRMS (TOF ES): found 388.2253, calculated for $C_{24}H_{31}NO_2Na$ (M + Na) 388.2252 (0.3 ppm).

***N*,*N*-Diethyl-2-(3-methoxyphenoxy)-1-phenylcyclopropane-1-carboxamide (15ad)**

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.) and 3-methoxyphenol (**14d**) (115 mg, 0.929 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 19 : 1), colorless oil, R_f 0.21 (hexanes/EtOAc 5 : 1). Yield 39.9 mg (0.118 mmol, 51%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.39–7.28 (m, 2H), 7.28–7.15 (m, 4H), 6.67–6.59 (m, 1H), 6.58–6.52 (m, 2H), 4.53 (dd, J = 6.1, 3.9 Hz, 1H), 3.79 (s, 3H), 3.67–3.49 (m, 2H), 3.27 (m, 2H), 1.96 (dd, J = 6.3, 4.0 Hz, 1H), 1.26 (t, J = 6.2 Hz, 1H), 1.17 (t, J = 7.0 Hz, 3H), 0.74 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.7, 160.7, 159.4, 139.4, 129.8 (+), 128.9 (+), 126.9 (+), 126.1 (+), 107.6 (+), 106.8 (+), 101.8 (+), 58.5 (+), 55.3 (+), 41.5 (−), 39.3 (−), 36.5, 23.6 (−), 12.9 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 3086, 2972, 2936, 2836, 1491, 1601, 1637, 1430, 1456, 1160, 762, 700; HRMS (TOF ES): found 362.1734, calculated for $C_{21}H_{25}NO_3Na$ (M + Na) 362.1732 (0.6 ppm).

2-(3-(Dimethylamino)phenoxy)-*N*,*N*-diethyl-1-phenylcyclopropane-1-carboxamide (15ae)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.) and 3-(dimethylamino)phenol (**14e**) (127 mg, 0.929 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 20 : 1), colorless oil, R_f 0.19 (hexanes/EtOAc 5 : 1). Yield 42.5 mg (0.121 mmol, 52%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.38–7.29 (m, 2H), 7.29–7.19 (m, 3H), 7.14 (t, J = 8.2 Hz, 1H), 6.44 (m, 1H), 6.39 (m, 1H), 6.31 (t, J = 2.4 Hz, 1H), 4.55 (dd, J = 6.1, 4.0 Hz, 1H), 3.69–3.50 (m, 2H), 3.27 (m, 2H), 2.92 (s, 6H), 1.97 (dd, J = 6.2, 3.9 Hz, 1H), 1.24 (t, J = 6.2 Hz, 1H), 1.17 (t, J = 7.1 Hz, 3H), 0.73 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.8, 159.3, 151.9, 139.6, 129.6 (+), 128.8 (+), 126.8 (+), 126.1 (+), 106.4 (+), 103.0 (+), 100.1 (+), 58.4 (+), 41.5 (−), 40.6 (+), 39.3 (−), 36.4, 23.7 (−), 12.9 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2973, 2934, 2804, 1638, 1614, 1500, 1429, 1244, 1159, 1139, 758, 699; HRMS (TOF ES): found 375.2035, calculated for $C_{22}H_{28}N_2O_2Na$ (M + Na) 375.2048 (3.5 ppm).

2-(4-Bromophenoxy)-*N*,*N*-diethyl-1-phenylcyclopropane-1-carboxamide (15af)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.) and 4-bromophenol (**14f**) (161 mg, 0.929 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 20 : 1), colorless solid, mp 89.3–89.4 °C, R_f 0.29 (hexanes/EtOAc 3 : 1). Yield 42.3 mg (0.109 mmol, 47%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.45–7.28 (m, 4H), 7.28–7.21 (m, 3H), 6.93–6.84 (m, 2H), 4.48 (dd, J = 6.1, 3.9 Hz, 1H), 3.67–3.50 (m, 2H), 3.33–3.18 (m, 2H), 1.92 (dd, J = 6.4, 3.9 Hz, 1H), 1.29 (t, J = 6.3 Hz, 1H), 1.15 (t, J = 7.1 Hz, 3H), 0.74 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.5, 157.3, 139.0, 132.2, 129.0 (+), 127.0 (+), 126.0 (+), 117.0 (+), 113.8 (+), 58.7 (+), 41.5 (−), 39.3 (−), 36.6, 23.2 (−), 12.9 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 3060, 2974, 2934, 2873, 1637, 1486, 1430, 1247, 1227, 699; HRMS (TOF ES): found 410.0731, calculated for $C_{20}H_{22}BrNO_2Na$ (M + Na) 410.0732 (0.2 ppm).

N,*N*-Diethyl-2-(naphthalen-2-yloxy)-1-phenylcyclopropane-1-carboxamide (15ag)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12a**)[13b] (50 mg, 0.232 mmol, 1.00 equiv.) and naphthalen-2-ol (**14g**) (134 mg, 0.929 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 19 : 1), colorless oil, R_f 0.31 (hexanes/EtOAc 5 : 1). Yield 49.1 mg (0.137 mmol, 59%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.80–7.72 (m, 3H), 7.48–7.43 (m, 1H), 7.42–7.40 (m, 1H), 7.38–7.24 (m, 6H), 7.10 (dd, J = 8.9, 2.5 Hz, 1H), 4.68 (dd, J = 6.1, 4.0 Hz, 1H), 3.71–3.51 (m, 2H), 3.43–3.21 (m, 2H), 2.02 (dd, J = 6.3, 4.0 Hz, 1H), 1.37 (t, J = 6.2 Hz, 1H), 1.20 (t, J = 7.0 Hz, 3H), 0.77 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.7, 156.1, 139.4, 134.4, 129.4 (+), 129.4, 128.9 (+), 127.7 (+), 126.9 (+), 126.9 (+), 126.4 (+), 126.1 (+), 123.9 (+), 118.6 (+), 108.3 (+), 58.5 (+), 41.5 (−), 39.3 (−), 36.6, 23.7 (−), 12.9 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 3058, 2974, 2934, 2873, 1633, 1600, 1511, 1467, 1430, 1316, 1215, 1177, 842, 748, 699; HRMS (TOF ES): found 382.1775, calculated for $C_{24}H_{25}NO_2Na$ (M + Na) 382.1783 (2.1 ppm).

2-(4-Methoxyphenoxy)-*N*,*N*-dimethyl-1-phenylcyclopropane-1-carboxamide (15bb)

The compound was prepared according to the typical procedure B, employing *N*,*N*-dimethyl-1-phenylcycloprop-2-ene-1-carboxamide (**12b**) (50 mg, 0.267 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (133 mg, 1.07 mmol, 4.00 equiv.) followed by preparative column chromatography on Silica gel to afford the title compound as colorless crystals, mp 125.6–125.9 °C, R_f 0.33 (hexanes/EtOAc 1 : 1). Yield 45.5 mg (0.147 mmol, 55%). ^{1}H NMR (600 MHz, chloroform-*d*) δ 7.36–7.30 (m, 2H), 7.27–7.19 (m, 3H), 6.98–6.92 (m, 2H), 6.88–6.80 (m, 2H), 4.44 (dd, J = 6.1, 4.0 Hz, 1H), 3.77 (s, 3H), 3.03 (s, 3H), 2.95 (s, 3H), 1.90 (dd, J = 6.4, 4.0 Hz, 1H), 1.29 (t, J = 6.3 Hz, 1H); ^{13}C NMR (151 MHz, chloroform-*d*) δ 168.7, 154.5, 152.2, 139.1, 128.9 (+), 126.8 (+), 125.8 (+), 116.4 (+), 114.6 (+), 59.8 (+), 55.7 (+), 37.8 (+), 36.3, 35.9 (+), 23.4 (−); FT IR (NaCl, cm^{-1}): 3001, 2929, 1644, 1507, 1223, 1034, 827, 755, 700, 609; HRMS (TOF ES): found 334.1419, calculated for $C_{19}H_{21}NO_3Na$ (M + Na) 334.1419 (0.0 ppm).

(2-Phenoxy-1-phenylcyclopropyl)(pyrrolidin-1-yl)methanone (15ca)

The compound was prepared according to the typical procedure B, employing (1-phenylcycloprop-2-en-1-yl)(pyrrolidin-1-yl)methanone (**12c**)[13b] (50 mg, 0.234 mmol, 1.00 equiv.) and phenol (**14a**) (88 mg, 0.938 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 33 : 1), colorless oil, R_f 0.20 (hexanes/EtOAc 3 : 1). Yield 49.9 mg (0.162 mmol, 69%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.38–7.21 (m, 7H), 7.05–6.94 (m, 3H), 4.48 (dd, J = 6.2, 4.0 Hz, 1H), 3.71–3.45 (m, 3H), 3.07–2.91 (m, 1H), 1.99 (dd, J = 6.3, 4.0 Hz, 1H), 1.94–1.68 (m, 4H), 1.29 (t, J = 6.2 Hz, 1H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 166.8, 158.1, 138.7, 129.4 (+), 128.9 (+), 126.9 (+), 126.4 (+), 121.6 (+), 115.4 (+), 58.4 (+), 46.7 (−), 46.4 (−), 37.5, 26.1 (−), 24.2 (−), 22.8 (−); FT IR (NaCl, cm^{-1}): 3059, 2972, 2875, 1637, 1598, 1494, 1429, 1229, 1169, 755, 698; HRMS (TOF ES): found 308.1647, calculated for $C_{20}H_{22}NO_2$ (M + H) 308.1651 (1.3 ppm).

(2-(4-Methoxyphenoxy)-1-phenylcyclopropyl)(pyrrolidin-1-yl)methanone (15cb)

The compound was prepared according to the typical procedure B, employing (1-phenylcycloprop-2-en-1-yl)(pyrrolidin-

1-yl)methanone (**12c**)[13b] (50 mg, 0.234 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (116 mg, 0.938 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 5 : 1), colorless crystals, mp 103.7–103.8 °C, R_f 0.19 (hexanes/EtOAc 2 : 1). Yield 61.6 mg (0.183 mmol, 78%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.38–7.29 (m, 2H), 7.29–7.20 (m, 3H), 6.98–6.90 (m, 2H), 6.87–6.78 (m, 2H), 4.43 (dd, J = 6.2, 4.0 Hz, 1H), 3.77 (s, 3H), 3.69–3.46 (m, 3H), 2.99 (m, 1H), 1.97 (dd, J = 6.3, 4.0 Hz, 1H), 1.92–1.66 (m, 4H), 1.25 (t, J = 6.2 Hz, 1H); ^{13}C NMR (151 MHz, chloroform-*d*) δ 166.9, 154.5, 152.2, 138.8, 128.9 (+), 126.8 (+), 126.4 (+), 116.4 (+), 114.6 (+), 59.2 (+), 55.8 (+), 46.7 (−), 46.4 (−), 37.6, 26.1 (−), 24.2 (−), 22.7 (−); FT IR (NaCl, cm^{-1}): 2970, 2876, 1635, 1507, 1430, 1217, 1036, 826, 756, 725, 700; HRMS (TOF ES): found 360.1559, calculated for $C_{21}H_{23}NO_3Na$ (M + Na) 360.1576 (4.7 ppm).

(2-(4-(*tert*-Butyl)phenoxy)-1-phenylcyclopropyl)(pyrrolidin-1-yl)methanone (15cc)

The compound was prepared according to the typical procedure B, employing (1-phenylcycloprop-2-en-1-yl)(pyrrolidin-1-yl)methanone (**12c**)[13b] (50 mg, 0.234 mmol, 1.00 equiv.) and 4-(*tert*-butyl)phenol (**14c**) (141 mg, 0.938 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 6 : 1), colorless oil, R_f 0.21 (hexanes/EtOAc 1 : 1). Yield 60.1 mg (0.165 mmol, 71%). ^{1}H NMR (600 MHz, chloroform-*d*) δ 7.35–7.28 (m, 3H), 7.28–7.22 (m, 4H), 6.99–6.92 (m, 2H), 4.47 (dd, J = 6.2, 4.0 Hz, 1H), 3.66–3.54 (m, 2H), 3.54–3.47 (m, 1H), 2.97 (dt, J = 10.3, 7.3 Hz, 1H), 1.99 (dd, J = 6.3, 4.0 Hz, 1H), 1.90–1.78 (m, 1H), 1.77–1.63 (m, 3H), 1.30 (s, 9H), 1.28 (t, J = 6.4 Hz, 1H); ^{13}C NMR (151 MHz, chloroform-*d*) δ 166.9, 155.8, 144.3, 138.8, 128.9 (+), 126.8 (+), 126.4 (+), 126.2 (+), 114.9 (+), 58.6 (+), 46.7 (−), 46.4 (−), 37.5, 34.1 (+), 31.5 (+), 26.1 (−), 24.2 (−), 22.8 (−); FT IR (NaCl, cm^{-1}): 3058, 2963, 2873, 1637, 1511, 1432, 1365, 1251, 1182, 830, 760, 729, 699, 551; HRMS (TOF ES): found 386.2095, calculated for $C_{24}H_{29}NO_2Na$ (M + Na) 386.2096 (0.3 ppm).

Morpholino(2-phenoxy-1-phenylcyclopropyl)methanone (15da)

The compound was prepared according to the typical procedure B, employing morpholino(1-phenylcycloprop-2-en-1-yl) methanone (**12d**)[13b] (50 mg, 0.218 mmol, 1.00 equiv.) and phenol (**14a**) (82 mg, 0.872 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 20 : 1), colorless oil, R_f 0.32 (hexanes/EtOAc 4 : 1). Yield 37.2 mg (0.115 mmol, 53%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.42–7.18 (m, 7H), 7.08–6.97 (m, 3H), 4.51 (dd, J = 6.1, 4.0 Hz, 1H), 4.11–3.92 (m, 1H), 3.81–3.39 (m, 6H), 3.37–3.26 (m, 1H), 1.95 (dd, J = 6.4, 4.0 Hz, 1H), 1.36 (t, J = 6.3 Hz, 1H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.2, 157.9, 138.7, 129.5 (+), 129.1 (+), 127.1 (+), 125.7 (+), 121.8 (+), 115.2 (+), 66.9 (−), 66.8 (−), 58.8 (+), 46.5 (−), 42.9 (−), 35.8, 23.6 (−); FT IR (NaCl, cm^{-1}): 3060, 2963, 2921, 2856, 1644, 1598, 1494, 1432, 1300, 1239, 1114, 755, 695; HRMS (TOF ES): found 346.1417, calculated for $C_{20}H_{21}NO_3Na$ (M + Na) 346.1419 (0.6 ppm).

(2-(4-Methoxyphenoxy)-1-phenylcyclopropyl)(morpholino)methanone (15db)

The compound was prepared according to the typical procedure B, employing morpholino(1-phenylcycloprop-2-en-1-yl) methanone (**12d**)[13b] (50 mg, 0.218 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (108 mg, 0.872 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as colorless crystals, mp 135.5–135.9 °C, R_f 0.21 (hexanes/EtOAc 2 : 1). Yield 51.1 mg (0.145 mmol, 66%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.41–7.29 (m, 2H), 7.29–7.17 (m, 3H), 7.01–6.91 (m, 2H), 6.88–6.82 (m, 2H), 4.46 (dd, J = 6.1, 4.0 Hz, 1H), 4.03–3.91 (m, 1H), 3.78 (s, 3H), 3.76–3.38 (m, 6H), 3.32 (m, 1H), 1.93 (dd, J = 6.4, 4.0 Hz, 1H), 1.32 (t, J = 6.2 Hz, 1H); ^{13}C NMR (151 MHz, chloroform-*d*) δ 167.2, 154.6, 151.9, 138.8, 129.0 (+), 127.1 (+), 125.7 (+), 116.1 (+), 114.7 (+), 66.9 (−), 66.8 (−), 59.4, 55.8, 46.5 (−), 42.9 (−), 35.8, 23.5 (−); FT IR (NaCl, cm^{-1}): 3056, 2961, 2917, 2855, 1644, 1507, 1433, 1367, 1231, 1205, 1114, 1035, 849, 753, 732, 700, 604; HRMS (TOF ES): found 376.1526, calculated for $C_{21}H_{23}NO_4Na$ (M + Na) 376.1525 (0.3 ppm).

(2-Phenoxy-1-phenylcyclopropyl)(piperidin-1-yl)methanone (15ea)

The compound was prepared according to the typical procedure B, employing (1-phenylcycloprop-2-en-1-yl)(piperidin-1-yl)methanone (**12e**)[13b] (50 mg, 0.22 mmol, 1.00 equiv.) and phenol (**14a**) (83 mg, 0.88 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 7 : 1), colorless oil, R_f 0.18 (hexanes/EtOAc 2 : 1). Yield 23.6 mg (0.073 mmol, 33%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.37–7.19 (m, 7H), 7.06–6.94 (m, 3H), 4.49 (dd, J = 6.1, 4.0 Hz, 1H), 3.81 (dt, J = 13.1, 4.9 Hz, 1H), 3.54 (m, 2H), 3.32 (dq, J = 12.9, 3.6 Hz, 1H), 1.92 (dd, J = 6.4, 4.0 Hz, 1H), 1.67–1.43 (m, 5H), 1.33 (t, J = 6.2 Hz, 1H), 1.27–1.14 (m, 1H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 166.8, 158.1, 139.3, 129.4 (+), 128.9 (+), 126.8 (+), 125.8 (+), 121.5 (+), 115.3 (+), 59.1 (+), 46.9 (−), 43.4 (−), 36.1, 25.9 (−), 25.7 (−), 24.6 (−), 23.7 (−); FT IR (NaCl, cm^{-1}): 3058, 2938, 2856, 2360, 1637, 1599, 1493, 1440, 1238, 1020, 754, 736, 698; HRMS (TOF ES): found 344.1626, calculated for $C_{21}H_{23}NO_2Na$ (M + Na) 344.1626 (0.0 ppm).

N,*N*-Diethyl-1-(4-fluorophenyl)-2-phenoxycyclopropane-1-carboxamide (15ja)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-(4-fluorophenyl)cycloprop-2-ene-1-carboxamide (**12j**) (45 mg, 0.193 mmol, 1.00 equiv.) and phenol (**14a**) (73 mg, 0.772 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 17 : 1), colorless oil, R_f 0.23 (hexanes/EtOAc 5 : 1). Yield 33 mg (0.101 mmol, 52%). ^{1}H NMR (600 MHz, chloroform-*d*) δ 7.35–7.20 (m, 4H), 7.06–6.96 (m, 5H), 4.50 (dd, J = 6.1, 4.0 Hz,

1H), 3.59 (m, 2H), 3.32–3.20 (m, 2H), 1.93 (dd, J = 6.3, 4.0 Hz, 1H), 1.23 (m, 1H), 1.16 (t, J = 7.1 Hz, 3H), 0.77 (t, J = 7.1 Hz, 3H); ^{13}C NMR (151 MHz, chloroform-d) δ 167.5, 161.7 (d, J = 246.0 Hz), 158.0, 135.2 (d, J = 3.3 Hz), 129.4 (+), 127.9 (d, J = 8.0 Hz) (+), 121.6 (+), 115.8 (d, J = 21.5 Hz) (+), 115.2 (+), 58.4 (+), 41.4 (–), 39.3 (–), 36.0, 23.5 (–), 13.0 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2973, 2933, 1637, 1599, 1513, 1494, 1430, 1245, 1223, 1166, 1146, 830, 754, 691, 565; HRMS (TOF ES): found 350.1538, calculated for $C_{20}H_{22}FNO_2Na$ (M + Na) 350.1532 (1.7 ppm).

N,*N*-Diethyl-1-(4-fluorophenyl)-2-(4-methoxyphenoxy) cyclopropane-1-carboxamide (15jb)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-(4-fluorophenyl)cycloprop-2-ene-1-carboxamide (**12j**) (45 mg, 0.193 mmol, 1.0 equiv.) and 4-methoxyphenol (**14b**) (96 mg, 0.772 mmol, 4.0 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 10 : 1), colorless oil, R_f 0.16 (hexanes/EtOAc 5 : 1). Yield 47 mg (0.131 mmol, 68%). ^{1}H NMR (400 MHz, chloroform-d) δ 7.28–7.20 (m, 2H), 7.06–6.98 (m, 2H), 6.95–6.88 (m, 2H), 6.86–6.79 (m, 2H), 4.45 (dd, J = 6.1, 4.0 Hz, 1H), 3.77 (s, 3H), 3.65–3.49 (m, 2H), 3.25 (m, 2H), 1.92 (dd, J = 6.3, 3.9 Hz, 1H), 1.19 (t, J = 6.3 Hz, 1H), 1.15 (t, J = 7.0 Hz, 3H), 0.76 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-d) δ 167.6, 161.6 (d, J = 246.1 Hz), 154.4, 152.1, 135.26 (d, J = 3.5 Hz), 127.8 (d, J = 8.1 Hz) (+), 116.1 (+), 115.8 (d, J = 21.7 Hz) (+), 114.6 (+), 59.0 (+), 55.7 (+), 41.4 (–), 39.3 (–), 36.1, 23.4 (–), 13.0 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2974, 2936, 2834, 1637, 1506, 1464, 1431, 1378, 1238, 1222, 1039, 827, 745; HRMS (TOF ES): found 380.1635, calculated for $C_{21}H_{24}FNO_3Na$ (M + Na) 380.1638 (0.8 ppm).

(1-(4-Fluorophenyl)-2-phenoxycyclopropyl)(pyrrolidin-1-yl) methanone (15ka)

The compound was prepared according to the typical procedure B, employing (1-(4-fluorophenyl)cycloprop-2-en-1-yl) (pyrrolidin-1-yl)methanone (**12k**) (50 mg, 0.216 mmol, 1.0 equiv.) and phenol (**14a**) (81 mg, 0.865 mmol, 4 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 11 : 1), colorless oil, R_f 0.17 (hexanes/EtOAc 3 : 1). Yield 42.3 mg (0.13 mmol, 60.1%). ^{1}H NMR (600 MHz, chloroform-d) δ 7.33–7.22 (m, 4H), 7.06–6.95 (m, 5H), 4.43 (dd, J = 6.2, 4.0 Hz, 1H), 3.70–3.63 (m, 1H), 3.62–3.54 (m, 1H), 3.53–3.46 (m, 1H), 3.03–2.96 (m, 1H), 1.96 (dd, J = 6.3, 4.0 Hz, 1H), 1.92–1.83 (m, 1H), 1.82–1.70 (m, 3H), 1.26 (t, J = 6.3 Hz, 1H); ^{13}C NMR (151 MHz, chloroform-d) δ 166.7, 161.7 (d, J = 246.4 Hz), 158.0, 134.4 (d, J = 3.3 Hz), 129.4 (+), 128.3 (d, J = 8.0 Hz) (+), 121.7 (+), 115.8 (d, J = 21.5 Hz) (+), 115.4 (+), 58.4 (+), 46.6 (–), 46.5 (–), 37.0, 26.1 (–), 24.2 (–), 22.6 (–); FT IR (NaCl, cm^{-1}): 3062, 2973, 2876, 1636, 1600, 1434, 1229, 831, 755, 692, 559; HRMS (TOF ES): found 348.1368, calculated for $C_{20}H_{20}FNO_2Na$ (M + Na) 348.1376 (2.3 ppm).

(1-(4-Fluorophenyl)-2-(4-methoxyphenoxy)cyclopropyl) (pyrrolidin-1-yl)methanone (15kb)

The compound was prepared according to the typical procedure B, employing (1-(4-fluorophenyl)cycloprop-2-en-1-yl) (pyrrolidin-1-yl)methanone (**12k**) (50 mg, 0.216 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (107 mg, 0.865 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as colorless crystals, mp 116.7–116.9 °C, R_f 0.15 (hexanes/EtOAc 3 : 1). Yield 59.7 mg (0.168 mmol, 78%). ^{1}H NMR (600 MHz, chloroform-d) δ 7.29–7.21 (m, 2H), 7.05–6.98 (m, 2H), 6.95–6.91 (m, 2H), 6.85–6.80 (m, 2H), 4.38 (dd, J = 6.2, 4.0 Hz, 1H), 3.77 (s, 3H), 3.67–3.61 (m, 1H), 3.61–3.54 (m, 1H), 3.53–3.46 (m, 1H), 3.02–2.95 (m, 1H), 1.95 (dd, J = 6.3, 4.0 Hz, 1H), 1.90–1.82 (m, 1H), 1.81–1.70 (m, 3H), 1.21 (t, J = 6.3 Hz, 1H); ^{13}C NMR (151 MHz, chloroform-d) δ 166.8, 161.7 (d, J = 245.5 Hz), 154.5, 152.1, 134.5 (d, J = 4.2 Hz), 128.3 (d, J = 8.3 Hz) (+), 116.4 (+), 115.8 (d, J = 21.0 Hz) (+), 114.6 (+), 59.1 (+), 55.8 (+), 46.6 (–), 46.5 (–), 37.0, 26.1 (–), 24.2 (–), 22.5 (–); FT IR (NaCl, cm^{-1}): 3048, 2972, 2876, 2835, 1635, 1506, 1435, 1220, 1037, 828, 732, 560; HRMS (TOF ES): found 378.1487, calculated for $C_{21}H_{22}FNO_3Na$ (M + Na) 378.1481 (1.6 ppm).

(2-(4-(*tert*-Butyl)phenoxy)-1-(4-fluorophenyl)cyclopropyl) (pyrrolidin-1-yl)methanone (15kc)

The compound was prepared according to the typical procedure B, employing (1-(4-fluorophenyl)cycloprop-2-en-1-yl) (pyrrolidin-1-yl)methanone (**12k**) (50 mg, 0.216 mmol, 1.00 equiv.) and 4-(*tert*-butyl)phenol (**14c**) (130 mg, 0.865 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 75 : 1), colorless oil, R_f 0.12 (hexanes/EtOAc 5 : 1). Yield 60.1 mg (0.158 mmol, 73%). ^{1}H NMR (500 MHz, chloroform-d) δ 7.33–7.28 (m, 2H), 7.28–7.23 (m, 2H), 7.06–6.98 (m, 2H), 6.96–6.90 (m, 2H), 4.42 (dd, J = 6.2, 4.0 Hz, 1H), 3.67–3.53 (m, 2H), 3.49 (m, 1H), 3.02–2.91 (m, 1H), 1.97 (dd, J = 6.3, 4.0 Hz, 1H), 1.85 (m, 1H), 1.80–1.67 (m, 3H), 1.30 (s, 9H), 1.24 (t, J = 6.3 Hz, 1H); ^{13}C NMR (126 MHz, chloroform-d) δ 166.7, 161.7 (d, J = 246.1 Hz), 155.6, 144.4, 134.6 (d, J = 3.5 Hz), 128.3 (d, J = 8.1 Hz) (+), 126.2 (+), 115.8 (d, J = 21.7 Hz) (+), 114.9 (+), 58.6 (+), 46.6 (–), 46.4 (–), 36.9, 34.1 (+), 31.5 (+), 26.1 (–), 24.2 (–), 22.6 (–); FT IR (NaCl, cm^{-1}): 3043, 2964, 2873, 1637, 1510, 1434, 1250, 1182, 829, 735, 559; HRMS (TOF ES): found 404.2004, calculated for $C_{24}H_{28}FNO_2Na$ (M + Na) 404.2002 (0.5 ppm).

N,*N*-Diethyl-1-(3-fluorophenyl)-2-phenoxycyclopropane-1-carboxamide (15la)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-(3-fluorophenyl)cycloprop-2-ene-1-carboxamide (**12l**) (50 mg, 0.214 mmol, 1.00 equiv.) and phenol (**14a**) (81 mg, 0.857 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 12 : 1), colorless oil, R_f 0.2 (hexanes/EtOAc 1 : 1). Yield 35.2 mg

(0.108 mmol, 50%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.34–7.26 (m, 3H), 7.04 (m, 1H), 7.02–6.91 (m, 5H), 4.51 (dd, J = 6.1, 4.0 Hz, 1H), 3.68–3.48 (m, 2H), 3.35–3.23 (m, 2H), 1.98 (dd, J = 6.4, 4.0 Hz, 1H), 1.28 (t, J = 6.3 Hz, 1H), 1.18 (t, J = 7.1 Hz, 3H), 0.81 (t, J = 7.1 Hz, 3H); ^{13}C NMR (151 MHz, chloroform-*d*) δ 167.1, 163.1 (d, J = 246.6 Hz), 158.0, 142.0 (d, J = 7.6 Hz), 130.4 (d, J = 8.4 Hz) (+), 129.4 (+), 121.7 (d, J = 2.9 Hz) (+), 121.6 (+), 115.2 (+), 113.9 (d, J = 20.9 Hz) (+), 113.1 (d, J = 22.2 Hz) (+), 58.6 (+), 41.5 (–), 39.3 (–), 36.3 (d, J = 2.2 Hz), 24.0 (–), 13.0 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 3062, 2975, 2935, 2875, 1637, 1588, 1492, 1430, 1365, 1249, 1268, 1138, 842, 754, 692; HRMS (TOF ES): found 350.1534, calculated for $C_{20}H_{22}FNO_2Na$ (M + Na) 350.1532 (0.6 ppm).

N,*N*-Diethyl-1-(3-fluorophenyl)-2-(4-methoxyphenoxy) cyclopropane-1-carboxamide (15lb)

The compound was prepared according to the typical procedure B, employing *N*,*N*-diethyl-1-(3-fluorophenyl)cycloprop-2-ene-1-carboxamide (**12l**) (50 mg, 0.214 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (106 mg, 0.875 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 17 : 1), colorless crystals, mp 104.1–104.4 °C, R_f 0.36 (hexanes/EtOAc 3 : 1). Yield 54.3 mg (0.152 mmol, 71%). ^{1}H NMR (600 MHz, chloroform-*d*) δ 7.32–7.27 (m, 1H), 7.03 (m, 1H), 6.97–6.90 (m, 4H), 6.85–6.81 (m, 2H), 4.46 (dd, J = 6.2, 4.0 Hz, 1H), 3.77 (s, 3H), 3.60 (m, 1H), 3.52 (m, 1H), 3.28 (m, 2H), 1.96 (dd, J = 6.4, 4.0 Hz, 1H), 1.24 (t, J = 6.3 Hz, 1H), 1.17 (t, J = 7.1 Hz, 3H), 0.80 (t, J = 7.1 Hz, 3H); ^{13}C NMR (151 MHz, chloroform-*d*) δ 167.2, 163.1 (d, J = 246.5 Hz), 154.5, 152.0, 142.1 (d, J = 7.6 Hz), 130.4 (d, J = 8.4 Hz) (+), 121.7 (d, J = 2.9 Hz) (+), 116.1 (+), 114.6 (+), 113.8 (d, J = 20.9 Hz) (+), 113.1 (d, J = 22.5 Hz) (+), 59.2 (+), 55.7 (+), 41.5 (–), 39.3 (–), 36.4 (d, J = 2.1 Hz), 23.9 (–), 13.0 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2974, 2936, 2835, 1636, 1586, 1506, 1430, 1241, 1216, 1138, 1036, 825, 784, 742, 695; HRMS (TOF ES): found 380.1636, calculated for $C_{21}H_{24}FNO_3Na$ (M + Na) 380.1638 (0.5 ppm).

1-(3-Fluorophenyl)-2-(4-methoxyphenoxy)-*N*,*N*-dimethylcyclopropane-1-carboxamide (15mb)

The compound was prepared according to the typical procedure B, employing 1-(3-fluorophenyl)-*N*,*N*-dimethylcycloprop-2-ene-1-carboxamide (**12m**) (50 mg, 0.244 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (121 mg, 0.975 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as colorless crystals, mp 131.5–132.0 °C, R_f 0.17 (hexanes/EtOAc 5 : 1). Yield 51.2 mg (0.155 mmol, 64%). ^{1}H NMR (600 MHz, chloroform-*d*) δ 7.29 (td, J = 8.0, 6.1 Hz, 1H), 6.98 (m, 1H), 6.96–6.87 (m, 4H), 6.86–6.80 (m, 2H), 4.41 (dd, J = 6.2, 4.1 Hz, 1H), 3.77 (s, 3H), 3.04 (s, 3H), 2.95 (s, 3H), 1.93 (dd, J = 6.5, 4.1 Hz, 1H), 1.30 (t, J = 6.3 Hz, 1H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 168.1, 163.2 (d, J = 246.2 Hz), 154.6, 152.0, 141.8 (d, J = 7.3 Hz), 130.5 (d, J = 8.2 Hz) (+), 121.3 (d, J = 3.2 Hz) (+), 116.4 (+), 114.6 (+), 113.8 (d, J = 20.9 Hz) (+), 112.8 (d, J = 22.2 Hz) (+), 60.0 (+), 55.5 (+), 37.4 (+), 36.1, 35.9, 23.7 (–); FT IR (NaCl, cm^{-1}): 3001, 2932, 2835, 2360, 2341, 1645, 1507, 1223, 1137, 1036, 825, 784, 695; HRMS (TOF ES): found 352.132, calculated for $C_{19}H_{20}FNO_3Na$ (M + Na) 352.1325 (1.4 ppm).

1-(3-Bromophenyl)-*N*,*N*-diethyl-2-(4-methoxyphenoxy) cyclopropane-1-carboxamide (15nb)

The compound was prepared according to the typical procedure B, employing 1-(3-bromophenyl)-*N*,*N*-diethylcycloprop-2-ene-1-carboxamide (**15n**) (50 mg, 0.17 mmol, 1.00 equiv.) and 4-methoxyphenol (**14b**) (84 mg, 0.68 mmol, 4.00 equiv.) followed by preparative column chromatography on silica gel to afford the title compound as an inseparable mixture of diastereomers (dr 25 : 1), colorless oil, R_f 0.17 (hexanes/EtOAc 5 : 1). Yield 46 mg (0.11 mmol, 65%). ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.42–7.34 (m, 2H), 7.20 (dd, J = 4.4, 1.4 Hz, 2H), 6.95–6.88 (m, 2H), 6.86–6.80 (m, 2H), 4.46 (dd, J = 6.1, 4.1 Hz, 1H), 3.77 (s, 3H), 3.67–3.54 (m, 1H), 3.58–3.45 (m, 1H), 3.28 (s, 2H), 1.96 (dd, J = 6.4, 4.0 Hz, 1H), 1.24 (t, J = 6.3 Hz, 1H), 1.17 (t, J = 7.1 Hz, 3H), 0.81 (t, J = 7.1 Hz, 3H); ^{13}C NMR (126 MHz, chloroform-*d*) δ 167.1, 154.5, 152.0, 141.9, 130.4, 130.0 (+), 129.0 (+), 124.9 (+), 123.0 (+), 116.1 (+), 114.6 (+), 59.0 (+), 55.7 (+), 41.5 (–), 39.3 (–), 36.3, 23.8 (–), 13.0 (+), 12.3 (+); FT IR (NaCl, cm^{-1}): 2973, 2934, 2833, 1637, 1507, 1476, 1430, 1364, 1237, 1214, 1037, 853, 825, 784, 695; HRMS (TOF ES): found 418.1003, calculated for $C_{21}H_{25}BrNO_3$ (M + H) 418.1018 (3.6 ppm).

Conflicts of interest

There are no conflicts to declare.

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15 See ref. 9*b* for a discussion on the ion-templating effect and computational studies of the mechanism involving chelation of the cyclopropene substrate and alkoxide nucleophile around the potassium cation.

16 It should be pointed out that anilides are not compatible with this reaction, as the aromatic amide bond is readily cleaved under these reaction conditions; see ref. 12.