Charge-Directed Conjugate Addition Reactions of Silylated α-β-Unsaturated Amidate Anions

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A variety of N-substituted α-silylated-α,β-unsaturated amidate anions (2) have been found to be excellent Michael acceptors in charge-directed conjugate addition reactions with Grignard and organolithium reagents. The effects of olefin substitution, Si-substitution, N-substitution, and amidate counterion have been studied. Anionic acceptors may be prepared *in situ* by the addition of silylated vinyllithium reagents to isocyanates and then allowed to undergo conjugate addition reactions with subsequently added nucleophiles, but it was found to be more efficient to isolate neutral acceptors and regenerate the acceptor anion through the use of excess nucleophile. β-Substituted acceptors were found to react only with reactive organolithium reagents while a β,β-disubstituted acceptor failed to undergo conjugate addition reactions. A primary amide acceptor (**14d**) also undergoes addition reactions with larger quantitites of nucleophiles suggesting that dianionic amidate acceptors (**31**) are involved. Diene acceptor **24** was found to undergo a 1,6-addition reaction with *n*-BuLi. Sodium and potassium amidate salts were found to be inferior to lithium and magnesium salts in addition reactions in keeping with the expectation that an increase in carbonyl-group charge burden retards conjugate reactions. Triphenylsilyl-containing acceptor **16** was found to be more reactive in reactions with *n*-BuMgCl but less reactive with bulkier *tert*-BuMgCl. Adduct dianions can be monoalkylated with alkyl iodides and used in Peterson olefination reactions.

Introduction

The addition of stabilized nucleophiles to carbonyl-activated olefins constitutes an important class of carbon–carbon bond forming reactions.[2] In general, reactive nucelophiles such as Grignard and alkyllithium reagents undergo carbonyl 1,2-addition reactions with α,β-unsaturated carbonyl derivatives rather than Michael or conjugate addition reactions with the polarized olefinic unit. While reactions of strong nucleophiles with tertiary α,β-unsaturated amides likewise usually give products arising from carbonyl addition,[3] there are scattered exceptions.[4,5]

We have previously shown that the placement of a unit of negative charge adjacent to the carbonyl group in α,β-unsaturated carbonyl derivatives suppresses the 1,2-nucleophilic addition pathway thereby allowing the conjugate addition pathway to predominate.[6] Others have found that anions derived from certain secondary amides undergo such charge-directed conjugate addition reactions with some organolithium reagents.[7] In our study of charge-directed conjugate addition reactions of unsaturated carboxylate salts, we found that α-silylated-α,β-unsaturated carboxylate salts are excellent acceptors in reactions with Grignard and organolithium reagents.[6h] The beneficial effects of the α-silyl group presumably arise from the additional stabilization of the anions formed in the addition reactions as well as from suppression of polymerization reactions.[8] These results suggested that α-silylated-α,β-unsaturated amidate anions (**2**) also might be excellent acceptors in charge-directed conjugate addition reactions giving, after hydrolytic desilylation, β-substituted amides and thus a more general solution to the problem of 1,4- vs 1,2-addition in unsaturated amides. Futhermore, the required anionic acceptors (**2**) should be directly available from the addition of nucleophilic α-silylvinyl reagents (**1**) to isocyanates[9] enabling the overall reaction sequence shown in Scheme I. We anticipated that intermediate dianion **3** either could be protonated directly and then desilyated to give β-substituted amides **4** (E = H) or could be further elaborated at C_α by treatment with

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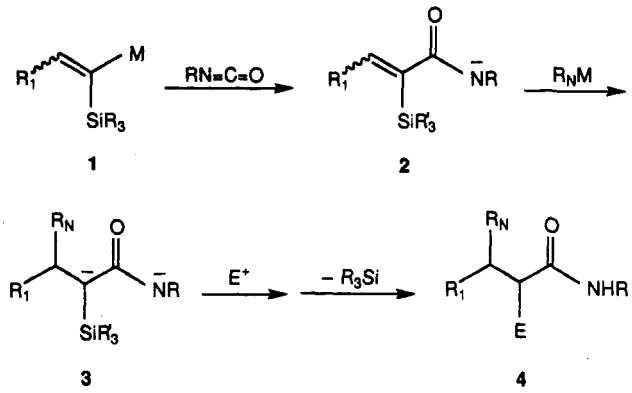
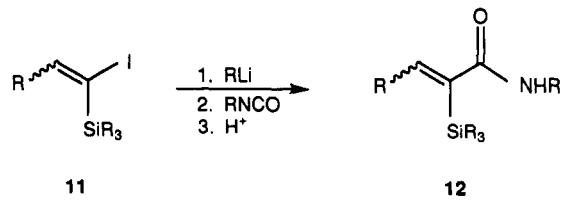
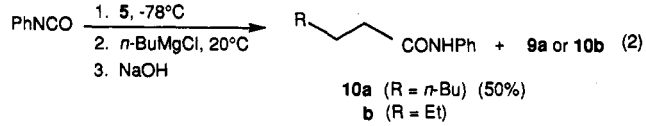
Scheme I



Scheme II



to execute owing to difficulties encountered in the introduction of exact quantities of organometallic reagents and typically reactions gave mixtures (eq 2). It proved most

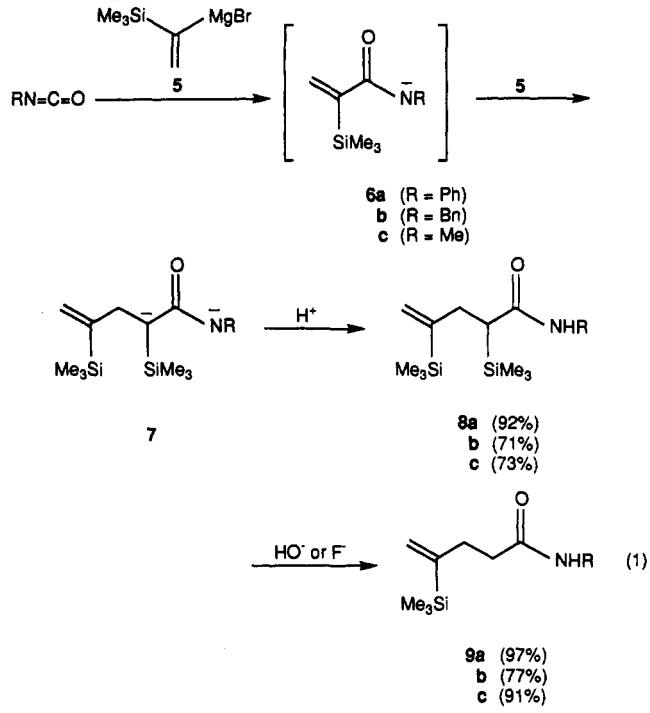


efficient to execute Scheme I in two steps: the preparation of protonated acceptors (2-H) by the addition of 1 to isocyanates followed by regeneration of acceptor anions 2 and subsequent conjugate addition to the anionic acceptor using the nucleophilic organometallic reagent as both the base and nucleophile. To this end, a variety of α-silylated-α,β-unsaturated amides were prepared and the conjugate addition reactions of their amidate anions were studied. The effects of N-substitution, β-substitution, Si-substitution, and amide counterion on conjugate addition reactions were investigated.

electrophiles prior to desilylation giving 4, E ≠ H. We now report the results of our exploration of this scheme.

Results and Discussion

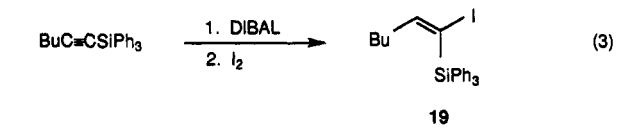
In order to test the feasibility of this scheme, several isocyanates were treated with excess trimethylsilyl vinyl magnesium bromide (5) as shown in eq 1. The addition



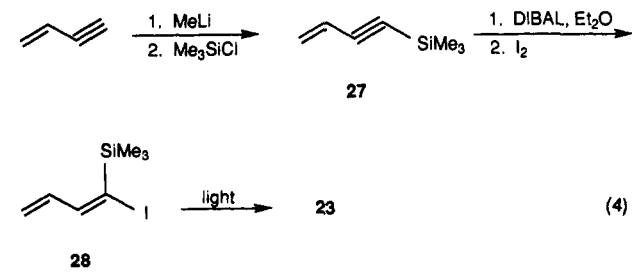
of phenyl isocyanate, benzyl isocyanate, or methyl isocyanate to a 4-fold excess of 5 in THF at -78 °C followed by reaction at 20 °C for 2 h gave silylated amides 8 in good yields. Removal of the α-trimethylsilyl group was readily accomplished by either brief heating with NaOH–MeOH–H_2O or by treatment with nBu$_4$NF.[10] While the formation of acceptor amidate anions 6 occurs rapidly at −78 °C, the conjugate addition reactions require higher temperatures (vide infra).

In principle, the execution of Scheme I should be achievable in a one-pot operation in which the nucleophilic vinylsilane 1 is allowed to react with an isocyanate at low temperature followed by the introduction of the appropriate Grignard or organolithium reagent which would then undergo the desired conjugate addition reaction at a higher temperature. In practice this proved to be tedious

Synthesis of Silylated Amides. Silylated amide ion precursors 12 in general were readily prepared by the addition of organolithium reagents to isocyanates at -78 °C followed by a protonation of the product amidate anions (Scheme II, Table I). The required organolithium reagents were in turn prepared from corresponding vinyl iodides 11 by lithium–iodine exchange reactions with either n-BuLi or *tert*-BuLi. Previously, unreported iodide 19 was prepared by the hydroalumination–iodination sequence shown in eq 3 which was patterned after the known



procedure for the preparation of 17.[11] Lithium–iodine exchange under conditions known to give retention of configuration[11,12] followed by protonation afforded (*Z*)-1-(triphenylsilyl)-1-hexene whose configuration followed from its ^{1}H NMR olefinic coupling constant (J = 14 Hz).[13] Iodo diene 23 was prepared as shown in eq 4. In this case



the hydroalumination–iodination sequence initially gave 28 (E/Z = 95:5), but this compound rapidly isomerized in sunlight to the *Z*-isomer 23 (>98% *Z*). The single primary amide 14d was prepared by the addition of 1-(trimeth-

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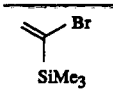
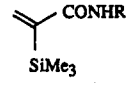
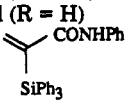
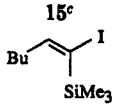
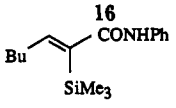
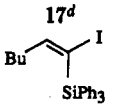
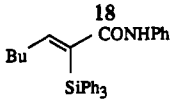
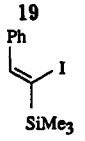
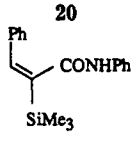
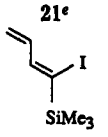
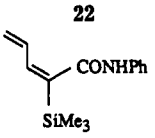
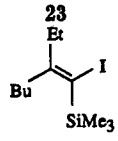
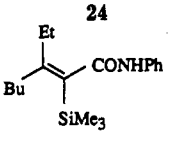
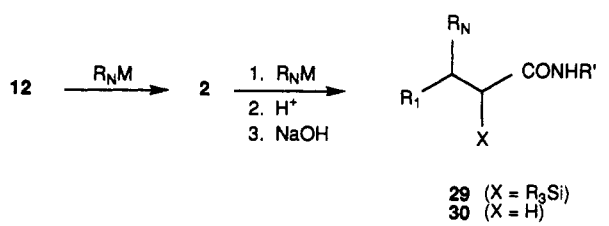
Table I. Silylated Unsaturated Amides (eq 3)

halide	RLi	RNCO	amide	% yield
	*a*	PhNCO		83
13[b]			**14** (R = Ph)	
13	*a*	BnNCO	**14b** (R = Bn)	78
13	*a*	MeNCO	**14c** (R = Me)	63
13	*tert*-BuLi	Me_3SiNCO	**14d** (R = H)	79
	*tert*-BuLi	PhNCO		65
15[c]			**16**	
	*n*-BuLi	PhNCO		76
17[d]			**18**	
	*n*-BuLi	PhNCO		69
19			**20**	
	*n*-BuLi	PhNCO		64
21[e]			**22**	
	*n*-BuLi	PhNCO		79
23			**24**	
	*tert*-BuLi	PhNCO		49
25[f]			**26**	

[a] Grignard reagent 5 used. [b] Reference 24. [c] Reference 25. [d] Reference 11. [e] Reference 6h. [f] Reference 26.

Scheme III



29 (X = R_3Si)
30 (X = H)

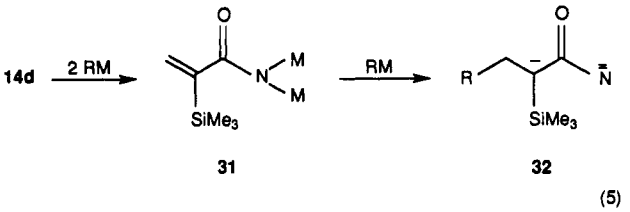
ylsilyl)vinyllithium to trimethylsilyl isocyanate followed by hydrolytic removal of the *N*-TMS group.[14]

Conjugate Addition Reactions. The conjugate addition reactions of a number of strong nucleophiles with amidate anions derived from silylated unsaturated amides **12** were investigated (Scheme III) and results are shown in Table II. In general, amides were added in THF to a 3-fold excess of the organometallic reagent at −78 °C, and then the mixture was kept at room temperature for 4 h prior to a protic quench (method A). It should be noted, however, that in the cases examined, inverse additions gave similar results. Workups which avoided elevated temperatures in the presence of alkali generally gave good yields of the α-silylated adducts **29**, although in many cases, as noted in Table II, adducts were directly desilylated to give **30** by briefly heating alkaline (NaOH) solutions of **29** in MeOH–H_2O.

In general, efficient addition reactions of Grignard and alkyllithium reagents to amidate acceptors occurred in all cases except the one derived from β,β-disubstituted acceptor **26**. Such highly substituted acceptors are often found to be resistant to Michael addition reactions[15] except in cases involving intramolecular addition reactions.[6g] The rate of addition of alkyllithium reagents to deprotonated acceptors **2** was found to be much faster than the reaction of the corresponding Grignard reagent to the same acceptor (entries 3, 7, and 8). The less-reactive nucleophiles 2-lithio-1,3-dithiane (entry 12) and *n*-$Bu_2Cu(CN)Li_2$ (entry 11) also undergo reactions with **14a**, but the enolate of *tert*-butyl acetate (entry 13) was unreactive.

It is interesting to note that the α-silyl group in **14a** does indeed render its amidate anion more reactive toward conjugate addition reactions than its unsilylated analog (*N*-phenyl acrylamide).[7b] The latter acceptor was found to react only poorly with PhLi and MeLi and not at all with PhMgBr and Me_2CuLi, while excellent results were obtained with **14a** in these cases (entries 10, 2, and 11).

It is also noteworthy that even unsubstituted amide **14d** undergoes conjugate addition reactions (entries 22–25); however, yields were lower under standard conditions employing 3 equiv of nucleophile (one of which is normally used to generate the amidate anion). Yields improved progressively when larger amounts of nucleophile were used (entries 23 and 25), suggesting that additional RM may be consumed in the formation of a dimetalated amide dianion **31** which may also undergo addition reactions giving trianions **32** (eq 5). Analogous di- and trianions



31 **32** (5)

have been reported in reactions of phenylacetamide with *n*-BuLi.[16]

In the cases involving β-substituted acceptors (entries 29–33), conjugate addition reactions were observed with alkyllithium reagents (entries 29, 31, and 33), but not with Grignard reagents (entries 30 and 32). In the case of the diene acceptor derived from **24**, only 1,6-addition was observed in its reaction with *n*-BuLi (entry 33). Protonation of the initial adduct gave an unresolved mixture of isomeric β,γ-unsaturated amides which, upon hydrogenation and desilylation afforded *N*-phenylnonanamide in good yield. Similar 1,6-addition has been observed with

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(16) Kaiser, E. M.; Vaux, R. L; Hauser, C. R. *J. Org. Chem.* **1967**, *32*, 3640.

Table II. Conjugate Addition Reactions of Unsaturated Amidate Anions

entry	acceptor	RM	method[a]	silylated (% yield)	R_1	R_N	R′	desilylated[b] (% yield)
1	**14a**	MeMgBr	A	**29a** (89)	H	Me	Ph	**30a** (92)
2		PhMgBr	A	**29b** (83)		Ph		**30b** (94)
3		c-C_5H_9MgBr	A	**29c** (88)		c-C_5H_9		**30c** (71)
4		CH_2=CHMgBr	A	**29d** (91)		CH_2=CH		**30d** (73)
5		CH_2=$CHCH_2$MgCl	A			CH_2=$CHCH_2$		**30e** (92)
6		*n*-BuMgCl	A			*n*-Bu		**30f** (99, 70[c])
7		*t*-BuMgCl	B			*t*-Bu		**30g** (52)
8		*n*-BuLi	A			*n*-Bu		**30f** (87)
9		*t*-BuLi	A			*t*-Bu		**30g** (83)
10		PhLi	A	**29b** (78)		Ph		**30b** (83)
11		*n*-$Bu_2CuCNLi_2$	A			*n*-Bu		**30f** (95)
12		2-lithio-1,3-dithiane	A			2-dithianyl		**30h** (97)
13		$LiCH_2COOBu^t$	C	(0)		CH_2COOBu^t		(0)
14	**14b**	PhMgBr	A		H	Ph	Bn	**30i** (91)
15		*n*-BuMgCl	A			Bu		**30j** (84)
16	**14c**	PhMgBr	A	**29k** (78)		Ph	Me	**30k** (61)
17		*n*-BuMgCl	A			*n*-Bu		**30l** (71)
18		c-C_5H_9MgBr	A			c-C_5H_9		**30m** (58)
19		*t*-BuMgCl	D			*t*-Bu		**30n** (68)
20		PhLi	A			Ph		**30k** (74)
21		*n*-BuLi	A			*n*-Bu		**30l** (74)
22	**14d**	*n*-BuMgCl	A			*n*-Bu	H	**30p** (30)
23		PhMgBr	E			Ph		**30q** (69)
24		*n*-BuLi	A			*n*-Bu		**30p** (58)
25		PhLi	E			Ph		**30q** (62, 34[d], 53[e])
26	**16**	*n*-BuLi	A			*n*-Bu	Ph	**30f**[f] (88)
27		*n*-BuMgCl	A			*n*-Bu		**30f**[f] (85)
28		PhMgBr	A			Ph		**30b**[f] (80)
29	**18**	*n*-BuLi	A		*n*-Bu	*n*-Bu		**30t** (93)
30		*n*-BuMgCl	A			*n*-Bu		**30t** (0)
31	**22**	*n*-BuLi	A		Ph	*n*-Bu		**30u** (52)
32		*n*-BuMgCl	A					**30u** (0)
33	**24**	*n*-BuLi	A		H	*n*-hexyl		(72)[g]
34	**26**	*n*-BuLi	A					(0)

[a] Method A: acceptor **12** added to 3 equiv of RM at −78 °C and then 20 °C, 4 h; B: as in A but 5 equiv RM and then 20 °C, 20 h; C: acceptor deprotonated with 1 equiv of *n*-BuLi followed by 1.1 equiv RM and then 0 °C, 4 h; D: as in B but 50 h; E: as in A but 4.5 equiv of RM.[b] **29** directly desilylated with NaOH–H_2O–MeOH, brief reflux. [c] Inverse addition of RM to acceptor. [d] Two equivalents of RM. [e] Equivalents of RM. [f] X = $SiPh_3$. [g] Hydrogenated (H_2, PtO_2) to *N*-phenylnonanamide.

cuprates and *N*,*N*-diethyl-2,4-hexadienamide[17] and with alkyllithium reagents and an analogous α-silylated 1,3-butadienyl borane acceptor.[18] Grignard reagents appeared to polymerize **24**.

The effects of the amidate counterion on the ease of conjugate addition reactions were also briefly investigated. The potassium and sodium amidate salts of **14a** (**2**, R = Ph, R_1 = H, R^1 = Me, M = K^+ or Na^+) were prepared from **14a** and KH and NaH or $NaN(SiMe_3)_2$, respectively. Both the sodium and potassium salts underwent addition reactions with excess *n*-BuMgCl under standard conditions (4 h, 20 °C) giving, after desilylation, **30f** in 83 and 75% yields, respectively. It is interesting to note that the sodium salt of **14a** is apparently a better Michael acceptor than the corresponding carbonylate salt which does not undergo addition reactions with Grignard reagents.[6h] When the chloromagnesium, sodium, and potassium salts of **14a** were treated with 0.9 equiv of *n*-BuMgCl under identical conditions (−15 °C, 1 h), **30f** was obtained in 53, 37, and 29% yields, respectively.[19] These data are in keeping with the expectation that amidates with less covalently bound counterions have a greater charge burden associated with the carbonyl unit and hence undergo conjugate addition reactions to give electron-rich "dianions" less readily.[6h,i] It should be added, however, that this interpretation is quite simplistic insomuch as no information is available on aggregate structure or metal–metal exchange.

The effect of substitution on silicon was also examined through acceptors **14a**, **16**, and **20**. The latter two acceptors containing the more electron-withdrawing triphenylsilyl group might be expected to be better Michael acceptors owing to an increase in adduct anion stability. However, β-substituted acceptor **20**, like its trimethylsilyl counterpart **18**, also failed to undergo addition reactions with Grignard reagents. In a competition experiment in which separate but equal amounts of **14a** and **16** were treated with 1.9 equivalents of *n*-BuMgCl (−30 °C, 1 h), adduct **30f** was obtained in 41 and 58% yield,[20] respectively, suggesting that triphenylsilyl-containng acceptor **16** is a slightly better acceptor. However, in a similar experiment with equivalent amounts of **14a** and **16** and 5 equiv of *tert*-BuMgCl (20 h at 20 °C) adduct **30g** was produced in 52 and 39% yields, respectively. In this case, the trimethylsilylated acceptor (**14a**) actually underwent the addition reaction at a faster rate with this nucleophile, and it is likely that the larger size of the triphenylsilyl group in **16** retards the reaction rate with bulky *tert*-BuMgCl.

Dianion Alkylation. The dianions (**3**, R_1 = H, R^1 = Me, R = Ph) generated upon the addition of Grignard or alkyllithium reagents to **14a** could be satisfactorily alky-

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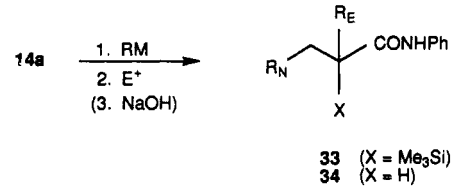
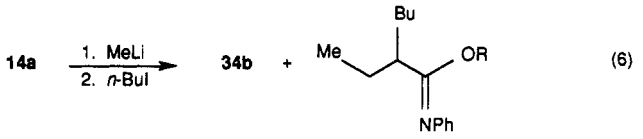
(19) The other product isolated in all cases was *N*-phenyl-3-methoxypropanamide, the product of MeOH addition to unreacted acceptor **14a** followed by desilylation.
(20) Additionally, *N*-phenyl 3-methoxypropanamide was isolated in 45% from **14a** and in 32% from **16**.[19]

Scheme IV



33 (X = Me_3Si)
34 (X = H)

lated by alkyl iodides as shown in Scheme IV and Table III. Reactions of lithium salts (entries 1–5) were notably faster than those of chloromagnesium salts (entries 6, 7) and the latter could only be alkylated with MeI. The use of benzyl chloride or benzyl bromide with chloromagnesium salts resulted in the formation of complex mixtures containing significant amounts of protonated adducts **33** (R_E = H). In the alkylation of the lithium adduct in entry 3, the longer reaction time required with *n*-BuI as the alkylating agent resulted in some O-alkylation[21] of the amidate monoanion as well (eq 6). The initially formed



(6)

35a (R = *n*-Bu)
b (R = Me)

butyl imidate ester **35a** was converted into the corresponding methyl ester (**35b**) under the conditions used for desilylation (NaOH–MeOH). The problem of overalkylation results in part from the use of an excess of the alkylating agent which is required in most cases to offset the excess nucleophile used in the standard conjugate addition reaction procedure (Table II). Thus while the nucleophilicity of these tertiary α-silylated enolate dianions appears lower than that of unsilylated amide dianions,[22] they are more reactive than the corresponding α-silyl carbonylate dianions which were found to be resistant to α-alkylation under these conditions.[5h]

Peterson Olefinations. Silyl dianions **3** resulting from conjugate addition reactions were found to readily condense with pentanal and undergo Peterson-type olefination reactions[23] (Scheme V, Table IV). Yields were found to be slightly better with lithium salts than with magnesium salts. In all cases, mixtures of stereoisomeric olefins were obtained with the E-isomer predominating in most cases. The stereochemistry of isomeric olefins followed from ^{1}H NMR spectra where olefinic hydrogens cis to the carbonyl group in *Z*-isomers occur at lower field.[27]

Experimental Section

General. *n*-BuLi in hexane, *tert*-BuLi in pentane, PhLi in cyclohexane–diethyl ether, *n*-BuMgCl, *tert*-BuMgCl, MeMgBr, and PhMgBr in diethyl ether, and allylmagnesium chloride, and vinylmagnesium bromide in tetrahydrofuran (THF) were obtained from Aldrich Chemical Co. Reactions involving organometallic reagents were conducted under an argon atmosphere. Reactions conducted at −78 °C employed a dry ice-acetone bath. THF and diethyl ether were distilled from sodium benzophenone ketyl. Column chromatography was conducted with Baker 60–200 mesh silica powder as described by Still *et al.*[28] Preparative thin-layer chromatography (PTLC) employed Merck 60 PF_{254} silica gel. ^{1}H NMR spectra (90 MHz) and ^{13}C NMR spectra (22.5 MHz) were recorded on $CDCl_3$ solutions with TMS as an internal standard. Melting points and boiling points are uncorrected. Boiling points for bulb-to-bulb distillations refer to air bath temperatures. Analyses were performed by Galbraith Laboratories, Knoxville, TN.

***N*-Phenyl-2,4-bis(trimethylsilyl)-4-pentenamide (8a).** To a 0.6 M solution of 1-(trimethylsilyl)vinylmagnesium bromide[29] (**5**) (9.2 mL, 5.5 mmol) in THF at −78 °C was added freshly distilled phenyl isocyanate (0.14 mL, 1.3 mmol). The reaction mixture was warmed to 20 °C and stirred for 2 h, whereupon it was quenched with methanol (0.4 mL). The solvent was removed under reduced pressure and the residue was treated with 10 mL of Et_2O. Water was added and the aqueous phase was acidified to pH < 2 with 10% HCl. The aqueous phase was extracted with Et_2O, and the extracts were washed with water, brine, and then dried (Na_2SO_4). The solvent was removed under reduced pressure and the crude product was recrystallized from methanol-water giving 0.38 g (92%) of **8a**: mp 121–124 °C; ^{1}H NMR δ 0.10 (s, 9 H), 0.13 (s, 9 H), 1.9–2.0 (m, 3 H), 5.32 (bs, 1 H), 5.66 (bs, 1 H), 6.9–7.5 (m, 5 H); ^{13}C NMR δ −2.5, −1.4, 32.2, 39.9, 120.3, 123.8, 124.4, 128.8, 138.4, 151.5, 172.5. Anal. Calcd for $C_{17}H_{29}NOSi_2$: C, 63.89; H, 9.15; N, 4.38. Found: C, 63.52; H, 9.07; N, 4.38.

Similarly prepared **8b**: PTLC (10:1 CH_2Cl_2–EtOAc), 71%; mp 95.5–97.0 °C; ^{1}H NMR: δ 0.07 (s, 18 H), 1.8–2.8 (m, 3 H), 4.36 (d, *J* = 5.8 Hz, 2 H), 5.31 (bs, 1 H), 5.60 (bs, 1 H), 7.25 (bs, 5 H); ^{13}C NMR δ −2.5, −1.4, 32.2, 38.7, 43.7, 124.4, 127.2, 128.0, 128.5, 139.0, 151.4, 173.7. Anal. Calcd for $C_{18}H_{31}NOSi_2$: C, 64.80; H, 9.37; N, 4.20. Found: C, 64.56; H, 9.25; N, 4.30.

8c: PTLC (1:1 CH_2Cl_2–EtOAc), 73%; sublimed 75 °C (2 mm): mp 113-115 °C; ^{1}H NMR δ 0.09 (s, 18 H), 1.8–2.5 (m, 3 H), 1.97 (d, *J* = 2.7 Hz, 3 H), 5.32 (bs, 1 H), 5.58 (bs, 1 H); ^{13}C NMR δ −2.5, 1.3, 26.2, 32.2, 38.9, 124.2, 151.8, 174.7. Anal. Calcd for $C_{12}H_{27}NOSi_2$: C, 55.97; H, 10.57; N, 5.44. Found: C, 55.64; H, 10.26; N, 5.17.

General Procedure for the Alkaline Desilylation of α-Silylated Amides. *N*-Phenyl-4-(trimethylsilyl)-4-pentenamide (9a). A solution containing 214 mg (0.67 mmol) of **8a** in 10 mL of MeOH was treated with 3 mL of 6 M NaOH and heated at reflux for 25 min. The solution was cooled and the methanol was removed under reduced pressure. The aqueous solution was acidifed to pH < 2 with 10% HCl and then extracted with Et_2O. The extracts were washed with H_2O and then brine, dried (Na_2SO_4), and concentrated. Recrystallization of the residue from pentane gave 143 mg (97%) of **9a**: mp 51–53 °C; ^{1}H NMR δ 0.11 (s, 9 H), 2.57 (bs, 4 H), 5.43 (bs, 1 H), 5.62 (bs, 1 H), 6.9–7.6 (m, 5 H), 8.19 (bs, 1 H); ^{13}C NMR δ −1.54, 31.0, 36.6, 120.4, 124.2, 128.8, 138.3, 150.9, 171.4. Anal. Calcd for $C_{14}H_{21}NOSi$: C, 67.96; H, 8.56; N, 5.66. Found: C, 67.83; H, 8.66; N, 5.56.

9b: bulb-to-bulb distillation (180 °C, 0.1 mm), 77%: ^{1}H NMR δ 0.08 (s, 9 H), 2.2–2.6 (m, 4 H), 4.4 (d, *J* = 5.7 Hz, 2 H), 5.36 (bs, 1 H), 5.54 (bs, 1 H), 5.75 (bs, 1 H), 7.27 (bs, 5 H); ^{13}C NMR δ −1.5, 31.2, 35.9, 43.7, 124.2, 127.5, 127.8, 128.7, 138.6, 151.1, 172.4. Anal. Calcd for $C_{15}H_{23}NOSi$: C, 68.91; H, 8.87; N, 53.6. Found: C, 68.70; H, 8.67; H, 5.05.

9c: bulb-to-bulb distillation (120 °C, 1 mm), 91%; mp 12–15 °C; ^{1}H NMR δ 0.09 (s, 9 H), 2.2–2.5 (m, 4 H), 2.79 (d, *J* = 4.6 Hz, 3 H), 5.36 (bs, 1 H), 5.54 (bs, 1 H); ^{13}C NMR: δ −1.5, 26.2, 31.2, 35.9, 124.1, 151.2, 173.4. Anal. Calcd for $C_9H_{19}NOSi$; C, 58.32; H, 10.33; N, 7.56. Found: C, 57.67; H, 10.30; N, 7.35.

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Table III. Tandem Conjugate Addition–Alkylation Reactions of 14a (Scheme IV)

entry	RM	E^+ (equiv)	alkylation conditions	product[a] (% yield)
1	MeLi	MeI (4)	0 °C, 1 h	**33a** (R_N = R_E = Me) (77)
2		EtI (4)	0 °C, 4 h	**34a** (R_N = Me, R_E = Et) (79)
3		*n*-BuI (4)	0 °C, 10 h	**34b** (R_N = Me, R_E = *n*-Bu) (52)[b]
4	*n*-BuLi	MeI (4)	0 °C, 1 h	**33b** (R_N = *n*-Bu, R_E = Me) (70)
				34c (R_N = *n*-Bu, R_E = Me) (67)
5		EtI (4)	0 °C, 2 h	**34d** (R_N = *n*-Bu, R_E = Et) (51)
6	*n*-BuMgCl	MeI (4)	20 °C, 2 h	**33b** (92)
7	MeMgCl	MeI (4)	20 °C, 2 h	**33a** (81)

[a] Products **34** were obtained by direct desilylation of **33** with NaOH, MeOH. [b] Bu(Et)CHC=NPh (OMe) was also isolated in 18% yield.

Scheme V

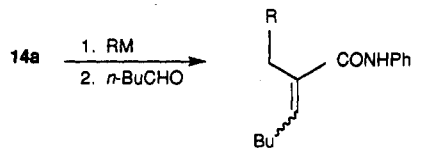

Table IV. Tandem Conjugate Addition–Peterson Olefination Reactions (Scheme V)

entry	RM	olefin (% yield)	*E*/*Z*
1	*n*-BuMgCl	**36a** (57)	1:1
2	PhMgBr	**36b** (61)	2:1
3	*n*-BuLi	**36a** (70)	3:1
4	PhLi	**36b** (77)	2:1

(*E*)-1-Iodo-1-(triphenylsilyl)-1-hexene (19). A solution of 1-(triphenylsilyl)-1-hexyne[30] (3.40 g, 9.98 mmol) in anhydrous Et_2O (15 mL) was treated dropwise with a 1.0 M solution of diisobutylaluminum hydride (DIBAL) in hexane (10.3 mL, 10.3 mmol). The reaction was stirred overnight. The mixture was then cooled to −78 °C and treated *via* cannula with a solution of iodine (3.0 g, 11 mmol) in anhydrous Et_2O (30 mL). After 15 min at −78 °C, the mixture was allowed to warm to 20 °C, and the contents were poured into a beaker containing 10% HCl (25 mL) and ice (100 g). After the ice had melted, the organic layer was separated. The aqueous phase was extracted with pentane (75 mL), and the combined organic extracts were washed with 10% NaOH, 1.0 M $Na_2S_2O_3$ (25 mL), and brine and then were dried over Na_2SO_4. After removal of the solvent, the crude product was recrystallized from petroleum ether giving 0.42 g (78%) of **19**: mp 66.5–68.0 °C; ^1H NMR δ 0.5–1.8 (b, 9 H), 5.26 (s, 1 H), 7.2–7.7 (m, 15 H); ^{13}C NMR δ 13.6, 22.0, 30.6, 36.4, 98.0, 127.9, 129.9, 134.0, 136.2, 162.1. Anal. Calcd for $C_{24}H_{25}ISi$: C, 61.54; H, 5.38. Found: C, 61.66; H, 5.59.

(*Z*)-1-Iodo-1-(trimethylsilyl)-1,3-butadiene (23). A solution containing 2.73 g (22 mmol) of **27**[31] and 25 mL (25 mmol) of 1 M DIBAH (in hexane) in 50 mL of Et_2O was allowed to stand overnight and then cooled to −78 °C and treated with stirring, over 2 min, with a solution containing 7.0 g (27 mmol) of I_2 in 50 mL of Et_2O. The mixture was stirred for 8 min and then warmed to 20 °C whereupon an aqueous solution of $NaHSO_3$ was added and stirring was continued until the solution was clear. The mixture was diluted with pentane, washed sequentially with water, 1 N HCl, water, and brine, and then dried over Na_2SO_4. The solution was concentrated on a steam bath and distilled (bulb-to-bulb, 130 °C, 15 mm) giving 3.13 g (56%) of a 1:1 mixture of **28** and **23**. Upon standing for 0.5 h in sunlight, the mixture was 98% **23** by capillary gas chromatographic analysis: ^1H NMR δ 0.21 (s, 9 H), 5.35 (m, 2 H), 6.4–6.8 (m, 2 H); ^{13}C NMR δ −1.5, 114.6, 122.1, 140.2, 144.1.

***N*-Phenyl-2-(trimethylsilyl)propenamide (14a).** A solution of approximately 0.6 M **5**[29] in THF (9.1 mL, 5.5 mmol) was cooled to −78 °C and with stirring was treated dropwise with 0.25 mL (2.3 mmol) of freshly distilled phenyl isocyanate. After 15 min, 0.4 mL of MeOH was added and the solvent was removed under reduced pressure. The residue was treated with water and the pH of the aqueous phase was adjusted to < 2 with 10% HCl and extracted with Et_2O. The ether extracts were washed with H_2O, dried (Na_2SO_4), and concentrated. Recrystallization of the residue from petroleum ether gave 417 mg (83%) of **14a**: mp 74–75 °C; ^1H NMR δ 0.23 (s, 9 H), 5.81 (d, J = 2.0 Hz, 1 H), 6.24 (d, J = 2.0 Hz, 1 H), 7.0–7.7 (m, 6 H); ^{13}C NMR: δ −1.4, 120.2, 124.2, 128.9, 130.0, 138.3, 151.4, 169.9. Anal. Calcd for $C_{12}H_{17}NOSi$: C, 65.70; H, 7.81; N, 6.39. Found: C, 65.41; H, 7.70; N, 6.28.

Similarly prepared from the appropriate isocyanate (Table I), **14b**: 78%; mp 61.5–62.0 °C; ^1H NMR δ 0.17 (s, 9 H), 4.39 (d, J = 5.9 Hz, 2 H), 5.66 (d, J = 2.2 Hz, 1 H), 6.07 (d, J = 2.0 Hz, 1 H), 7.24 (bs, 5 H); ^{13}C NMR: δ −1.4, 43.5, 127.3, 127.6, 128.6, 129.3, 138.8, 150.8, 171.6. Anal. Calcd for $C_{13}H_{19}NOSi$: C, 66.90; H, 8.21; N, 6.00. Found: C, 67.01; H, 8.12; N, 6.04.

14c: 63%; bp 69–71 °C (0.6 mm); ^1H NMR δ 0.17 (s, 9 H), 2.83 (d, J = 4.9 Hz, 3 H), 5.68 (d, J = 2.2 Hz, 1 H), 6.08 (d, J = 2.2 Hz, 1 H); ^{13}C NMR δ −1.4, 26.2, 129.3, 150.8, 172.7. Anal. Calcd for $C_7H_{15}NOSi$: C, 53.45; H, 9.61; N, 8.90. Found: C, 53.54; H, 9.75; N, 9.04.

2-(Trimethylsilyl)propenamide (14d). A solution of 1-(trimethylsilyl)vinyllithium[32] was prepared by treating a solution containing 1.4 mL (9.1 mmol) of **13** in 20 mL of THF at −78 °C with 9.8 mL (18 mmol) of 1.8 M *tert*-BuLi in pentane. To this solution was added at −78 °C 1.4 g (10 mmol) of a trimethylsilyl isocyanate (Aldrich) over 4 min. The solution was stirred for 70 min and then 1 mL of saturated NH_4Cl solution was added. The mixture was warmed to 20 °C and concentrated under reduced pressure. The residue treated with 2 mL of H_2O and 25 mL of Et_2O and the pH of the aqueous phase was adjusted to pH < 2 with 10% HCl. The aqueous phase was saturated with NaCl and twice more extracted with Et_2O. The extracts were washed with H_2O and then brine solution, dried (Na_2SO_4), and concentrated. The residue was recrystallized from hexane giving 1.03 g (79%) of **14d**: mp 82–85 °C; ^1H NMR: δ 0.19 (s, 9 H), 5.74 (d, J = 2.0 Hz, 1 H), 6.19 (d, J = 2.0 Hz, 1 H); ^{13}C NMR δ −1.4, 130.5, 150.1, 174.2. Anal. Calcd for $C_6H_{13}NOSi$: C, 50.30, H, 9.15; N, 9.78. Found: C, 50.58; H, 9.33; N, 9.60.

General Method for the Preparation of Neutral Acceptors. *N*-Phenyl-(*Z*)-2-(trimethylsilyl)-2-heptenamide (18). A solution containing (*Z*)-1-trimethylsilyl-1-hexen-1-yllithium[33] was prepared by the addition of 3.1 mL (5 mmol) of *n*-BuLi to 1.41 g (5 mmol) of **17**[11] in 20 mL of Et_2O at −78 °C. After 1 h, freshly distilled phenyl isocyanate (0.6 mL, 5.5 mmol) was added and stirring was continued for 1 h whereupon 0.25 mL of MeOH was added and the mixture was allowed to warm to 20 °C. Solvents were removed under reduced pressure, and the residue was treated with 10 mL of H_2O and 25 mL of Et_2O. The aqueous phase was acidified to pH < 2 by the addition of 10% HCl and twice more extracted with Et_2O (25 mL). The extracts were washed with H_2O and then brine solution and dried (Na_2SO_4). Solvent removal gave a residue which was purified by PTLC (CH_2Cl_2) giving 163 mg (76%) of **18** which was recrystallized from 95% EtOH giving needles: mp 141-142 °C (sublimes at 90 °C, 1.5 mm); ^1H NMR δ 0.25 (s, 9 H), 0.91 (t, J = 7.0 Hz, 3 H), 1.38 (m, 4 H), 2.18 (m, 2 H), 6.57 (t, J = 6.8 Hz, 1 H), 7.0–7.6 (m, 6 H); ^{13}C NMR δ 0.2, 13.9, 22.5, 31.5, 119.8, 124.0, 128.9, 138.4, 141.3, 148.2, 171.7. Anal. Calcd for $C_{16}H_{25}NOSi$: C, 69.76; H, 9.15; N, 5.08. Found: C, 69.77; H, 9.45; N, 4.90. In a similar manner the following unsaturated amides were prepared with variations noted below and in Table I.

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16: 2 equiv of *tert*-BuLi to **15**[25] in THF; 65%: mp 156–158 °C; ^{1}H NMR δ 5.95 (d, J = 2.5 Hz, 1 H), 6.94 (d, J = 2.5 Hz, 1 H), 6.8–7.8 (m, 20 H); ^{13}C NMR δ 119.5, 124.0, 128.3, 128.8, 130.3, 132.4, 136.2, 137.8, 141.1, 143.9, 168.1. Anal. Calcd for $C_{27}H_{23}NOSi$: C, 79.96; H, 5.72; N, 3.45. Found: C, 79.75; H, 5.64; N, 3.28.

20: 69% from 5:1 hexane–EtOAc; mp 165–167 °C; ^{1}H NMR δ 0.61 (t, J = 4.9 Hz, 3 H), 0.8–1.3 (b, 4 H), 1.6–2.0 (m, 2 H), 6.9–7.8 (m, 22 H); ^{13}C NMR δ 13.6, 22.2, 30.5, 32.8, 119.8, 123.8, 128.2, 128.5, 129.9, 133.5, 133.7, 136.0, 138.0, 157.8, 169.4. Anal. Calcd for $C_{31}H_{31}NOSi$: C, 80.65; H, 6.79; N, 3.03. Found: C, 80.47; H, 6.92; N, 3.05.

22: 64% from 95% EtOH; mp 198.0–198.5 °C; ^{1}H NMR δ 0.29 (s, 9 H), 6.84 (s, 1 H), 7.34 (m, 11 H); ^{13}C NMR δ −1.6, 120.1, 124.2, 128.4, 128.6, 128.9, 135.9, 137.8, 139.7, 142.8, 170.4. Anal. Calcd for $C_{18}H_{21}NOSi$: C, 73.17; H, 7.16; N, 4.74. Found: C, 73.38; H, 7.35; N, 4.52.

24: 79% from EtOH–H_2O; mp 161–162 °C; ^{1}H NMR δ 0.22 (s, 9 H), 5.2–5.5 (m, 2 H), 6.2–6.8 (m, 2 H), 7.1–7.7 (m, 5 H); ^{13}C NMR δ −1.5, 119.9, 122.1, 124.3, 129.0, 133.8, 137.9, 141.1, 143.3, 169.7. Anal. Calcd for $C_{14}H_{19}NOSi$: C, 68.52; H, 7.80; N, 5.71. Found: C, 68.20; H, 7.82; N, 5.63.

26: 2 equiv of *tert*-BuLi to **25** in THF; 49% from EtOH–H_2O: mp 117–118 °C; ^{1}H NMR δ 0.23 (s, 9 H), 0.7–1.5 (b, 10 H), 2.0–2.4 (m, 4 H), 6.9–7.6 (m, 6 H); ^{13}C NMR δ 0.3, 13.6, 14.0, 23.1, 27.4, 30.9, 34.2, 11.98, 124.0, 129.0, 135.6, 138.1, 158.0, 171.6. Anal. Calcd for $C_{18}H_{29}NOSi$: C, 71.23; H, 9.63; N, 4.61. Found: C, 71.36; H, 9.74; N, 4.59.

Conjugate Addition Reactions (Table II). Typical Procedure. *N*-Phenyl-2-(trimethylsilyl)butanamide (29a) (entry 1). A solution containing 1.0 mL (2.9 mmol) of 2.9 M MeMgBr in ether in 3 mL of THF was cooled to −78 °C and treated dropwise with stirring with a solution containing 219 mg (1.0 mmol) of **14a** in 3 mL of THF. After 1 min the mixture was allowed to warm to 20 °C where it was maintained for 4 h and then treated with 0.2 mL of MeOH. The solvent was removed under reduced pressure and the residue was treated with water (10 mL) and Et_2O (10 mL). The aqueous phase was acidified to pH = 2 by the addition 10% HCl and quickly extracted with Et_2O. The extracts were washed with water and then brine solution, dried (Na_2SO_4), and concentrated giving, after recrystallization from petroleum ether, 201 mg (89%) of **29a** which was sublimed at 65 °C (0.2 mm): mp 96–98 °C; ^{1}H NMR δ 0.10 (s, 9 H), 0.97 (t, J = 6.5 Hz, 3 H), 1.1–1.9 (m, 3 H), 7.0–7.7 (m, 5 H); ^{13}C NMR: δ −2.6, 15.0, 20.6, 43.0, 120.3, 123.8, 128.8, 138.4, 173.7. Anal. Calcd for $C_{31}H_{21}NOSi$: C, 66.33; H, 8.99; N, 5.95. Found: C, 66.48; H, 9.06; N, 5.88.

Similarly prepared with the variations noted below and in Table II, **29b**: 83%; PTLC (CH_2Cl_2); mp 159–161 °C; ^{1}H NMR δ 0.16 (s, 9 H), 2.14 (dd, J = 2.9, 11.0 Hz, 1 H), 2.72 (dd, J = 2.9, 14.0 Hz, 1 H), 3.28 (dd, J = 11.0, 14.0 Hz, 1 H), 3.28 (dd, J = 11.0, 14.0 Hz, 1 H), 7.0–7.4 (m, 11 H); ^{13}C NMR δ −2.6, 33.2, 43.4, 120.3, 123.9, 126.0, 128.2, 128.5, 128.8, 138.1, 142.4, 172.6. Anal. Calcd for $C_{18}H_{23}NOSi$: C, 72.68; H, 7.79; N, 4.71. Found: C, 72.61; H, 7.86; N, 4.90.

29c: 88%; PTLC (CH_2Cl_2); mp 144.0–144.5 °C; ^{1}H NMR δ 0.10 (s, 9 H), 0.25–2.0 (b, 12 H), 7.0–7.5 (m, 6 H); ^{13}C NMR δ −2.6, 25.2, 15.3, 32.3, 33.1, 33.6, 40.3, 40.8, 120.3, 123.8, 128.4, 138.6, 173.6. Anal. Calcd for $C_{17}H_{27}NOSi$: C, 70.53; H, 9.40; N, 4.84. Found: C, 70.94; H, 9.42; N, 4.92.

29d: 91%; PTLC (CH_2Cl_2); sublimed 75 °C (1 mm); mp 84–87 °C; ^{1}H NMR δ 0.11 (s, 9 H), 1.9–2.7 (m, 3 H), 4.8–5.0 (m, 2 H), 5.6–6.0 (m, 1 H), 6.9–7.3 (m, 5 H), 7.81 (bs, 1 H); ^{13}C NMR δ −2.5, 31.2, 40.2, 115.1, 120.5, 123.8, 128.7, 138.0, 138.4, 173.1. Anal. Calcd for $C_{14}H_{21}NOSi$: C, 67.97; H, 8.56; N, 5.66. Found: C, 67.58; H, 8.41; N, 5.70.

29k: 78%; PTLC (10:1 CH_2Cl_2–EtOAc); ^{1}H NMR δ 0.10 (s, 9 H), 1.97 (dd, J = 3.2, 11.2 Hz, 1 H), 2.62 (d, J = 4.6 Hz, 3 H), 2.7–3.3 (m, 2 H), 5.61 (bs, 1 H), 7.16 (bs, 5 H); ^{13}C NMR δ −2.6, 26.0, 33.3, 42.1, 125.9, 128.3, 142.7, 174.7.

Additions with Desilylation. Typical Procedure. *N*-Phenyl-3-[2-(1,3-dithianyl)] propanamide (30h). A solution of 2-lithio-1,3-dithiane,[34] prepared by the addition of 1.7 mL (2.8 mmol) of *n*-BuLi to 360 mg (3.0 mmol) of 1,3-dithiane in 10 mL of THF, was cooled to −78 °C and treated with a solution containing 215 mg (1.0 mmol) of **14a** in 3 mL of THF. After 1 min the mixture was warmed to 20 °C and after 4 h treated with 0.2 mL of MeOH. The solvent was removed under reduced pressure and the residue was dissolved in 10 mL of MeOH and heated under reflux whereupon 3 mL of 6 N NaOH was added and heating was continued for 25 min. The mixture was concentrated under reduced pressure and the residue was treated with 10 mL of Et_2O. The aqueous phase was adjusted to pH < 2 by the addition of 10% HCl and extracted with several portions of Et_2O. The extracts were dried (Na_2SO_4) and concentrated and the residue purified by PTLC (1:1 Et_2O–petroleum ether) giving, after recrystallization from EtOH–H_2O, **30h** as needles: mp 116–117 °C; ^{1}H NMR δ 1.7–2.3 (m, 4 H), 2.58 (t, J = 6.0 Hz, 2 H), 2.82 (dd, J = 6.8, 5.8 Hz, 4 H), 4.11 (t, J = 7.0 Hz, 1 H), 7.0–7.6 (m, 6H), 7.82 (bs, 1 H); ^{13}C NMR δ 25.9, 29.9, 30.7, 34.1, 46.4, 120.0, 124.2, 129.0, 137.9, 170.3. Anal. Calcd for $C_{13}H_{17}NOS_2$: C, 58.39; H, 6.41; N, 5.24. Found: C, 58.44; H, 6.59; N, 5.11.

The following amides were prepared with additions as described above in the preparation of **29a** followed directly by desilylation as described above in the preparation of **30h**. **30a**: 92%; mp 94.0–96.5 °C (lit.[35] mp 95 °C). **30b**: 94%; mp 95–97 °C (lit.[36] mp 97 °C). **30c**: 71%; mp 105–107 °C (lit.[37] mp 107–108 °C). **30d**: 73%; mp 90.5–92.5 °C (lit.[35] mp 91.4–91.8 °C). **30e**: 92%; mp 87–88 °C (lit.[38] mp 87–88 °C). **30f**: 99%; mp 63–64 °C (lit.[39] mp 64 °C). **30g**: 52%; mp 138.5–140.0 °C (lit.[40] mp 139–140 °C). **30i**: 91%; mp 84–86 °C (lit.[41] mp 84–85 °C). **30j**: 84%; mp 55–57 °C (lit.[42] mp 55.0–55.5 °C). **30k**: 61%; mp 60–62 °C (lit.[43] mp 62 °C). **30l**: 74%; n_D^{25} = 1.4397 (lit.[40] n_D^{25} = 1.4401).

30m: 58%; PTLC (45:5:1 CH_2Cl_2–EtOAc–HOAc); mp 41–43 °C; ^{1}H NMR δ 0.8–2.0 (b, 11 H), 2.20 (t, J = 7.0 Hz, 2 H), 2.78 (d, J = 4.9 Hz, 3 H), 6.55 (bs, 1 H); ^{13}C NMR δ 25.3, 26.2, 32.2, 32.6, 35.9, 40.0, 174.3. This compound was identical to an authentic sample prepared from 3-cyclopentylpropanoyl chloride and $MeNH_2$.

30n: 70%; PTLC (10:1 CH_2Cl_2–EtOAc); mp 53–55 °C; ^{1}H NMR δ 0.89 (s, 9 H), 1.51 (t, J = 11.0 Hz, 2 H), 2.15 (t, J = 11.0 Hz, 2 H), 2.79 (d, J = 4.9 Hz, 3 H), 5.50 (bs, 1 H); ^{13}C NMR δ 26.3, 29.1, 30.1, 32.2, 39.6, 174.5. Anal. Calcd for $C_8H_{17}NO$: C, 67.09; H, 11.96; N, 9.78. Found: C, 67.12; H, 11.61; N, 9.50.

30p: 30%; mp 94.0–94.5 °C (lit.[35] mp 94 °C). **30q**: 69%; mp 102–104 °C (lit.[45] mp 103 °C).

30t: 93%; PTLC (CH_2Cl_2); mp 52–55 °C; ^{1}H NMR δ 0.85 (t, J = 4.7 Hz, 6 H), 1.24 (b, 12 H), 2.0 (bs, 1 H), 2.26 (d, J = 6.5 Hz, 2 H), 6.8–7.4 (m, 5 H), 8.49 (bs, 1 H); ^{13}C NMR δ 14.1, 23.0, 28.8, 33.6, 35.4, 42.7, 120.4, 124.0, 128.7, 138.4, 172.2. Anal. Calcd for $C_{17}H_{27}NO$: C, 78.11; H, 10.41; N, 5.36. Found: C, 78.13; H, 10.41; N, 5.29.

30u: 52%; PTLC (CH_2Cl_2); mp 92–93 °C (lit.[46] mp 93–94 °C).

Additions to Alkali Metal Salts of 14a. Typical Example with a Sodium Salt. NaH (60 mg, 1.5 mmol), previously freed of oil by washing with pentane, was suspended in 3 mL of THF. A solution containing 219 mg (1.0 mmol) of **14a** in 3 mL of THF was added and the mixture stirred for 1 h. Vigorous H_2 evolution was observed. The mixture was cooled to −78 °C and treated with 0.45 mL (0.9 mmol) of *n*-BuMgCl. After 5 min, the temperature was raised to −15 °C where it was maintained for 1 h. MeOH (0.2 mL) was then added and the mixture was

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subjected to the standard workup and desilylation procedure (previously described in the preparation of **30h**) giving after PTLC (4:1 CH_2Cl_2–EtOAc) 70 mg (37%) of **30f**. A more-polar byproduct, *N*-phenyl-3-methoxypropanamide, resulting from MeOH addition to unreacted **14a** was also isolated: mp 40–42 °C; ^1H NMR δ 2.57 (t, J = 5.9 Hz, 2 H), 3.33 (s, 3 H), 3.67 (t, J = 5.9 Hz, 2 H), 7.32 (m, 5 H), 8.53 (bs, 1 H); ^{13}C NMR: δ 37.6, 58.3, 68.4, 120.0, 120.8, 128.5, 138.0, 169.7. Anal. Calcd for $C_{10}H_{13}NO_2$: C, 67.02; H, 7.31; N, 7.82. found: C, 66.81; H, 7.41; N, 7.75. Additions to potassium salts (from KH) were conducted in a similar manner.

Tandem Addition–Alkylation Reactions. Typical Procedure (Table III). *N*-Phenyl-2-methyl-2-(trimethylsilyl)-butanamide (33a). To a solution containing 1.8 mL (3.0 mmol) of 1.6 N MeLi (Et_2O) in 5 mL of THF at −78 °C was added 217 mg (1.0 mmol) of **14a** in 3 mL of THF. After 1 min the temperature was allowed to warm to 20 °C where it was maintained for 1 h. The mixture was then cooled to −78 °C and 0.25 mL (4.0 mmol) of MeI was added and the mixture kept at 0 °C for 1 h. HOAc (0.18 mL) was added and a standard workup (see **29a**) with PTLC (CH_2Cl_2) gave 190 mg (77%) of **33a**: mp 74–75 °C; ^1H NMR δ 0.08 (s, 9 H), 0.91 (t, J = 6.9 Hz, 3 H), 1.25 (s, 3 H), 1.3–2.3 (m, 2 H), 7.0–7.5 (m, 5 H); ^{13}C NMR δ −3.8, 9.0, 15.9, 26.9, 38.1, 120.3, 123.8, 128.7, 138.3, 174.9. Desilyation gave known N-phenyl-2-methylbutanamide.[47]

Similarly prepared (with variations noted in Table III), **33b**: 70% PTLC (CH_2Cl_2); sublimes at 60 °C (0.2 mm); mp 62–64 °C; ^1H NMR δ 0.08 (s, 9 H), 0.87 (t, J = 6.4 Hz, 3 H), 1.28 (bs, 10 H), 2.0 (bs, 1 H), 7.24 (m, 6 H); ^{13}C NMR δ −3.8, 14.1, 16.6, 22.6, 24.4, 32.5, 34.4, 37.8, 120.1, 123.9, 128.9, 138.3, 175.0. Anal. Calcd for $C_{17}H_{29}NOSi$: C, 70.04; H, 10.03; N, 4.80. Found: C, 70.35; H, 10.04; N, 4.78.

34a: 79%; PTLC (CH_2Cl_2): mp 124–126 °C (lit.[48] mp 126–127 °C). **34b**: 52%; PTLC (CH_2Cl_2): mp 87–89 °C (lit.[48] mp 88–89 °C). **35b**: 18%; ^1H NMR δ 0.7–1.7 (m, 14 H), 2.1–2.5 (m, 1 H), 3.76 (s, 3 H), 6.6–7.4 (m, 5 H); ^{13}C NMR δ 12.2, 13.9 22.7, 26.0, 29.9, 32.5, 41.6, 52.9, 121.4, 122.3, 128.7, 148.7, 165.3. **35b** was identical to an authentic sample prepared by the O-methylation of *N*-phenyl-2-ethylhexanamide with dimethyl sulfate.[49] **34c**: 67%; PTLC (CH_2Cl_2); mp 83–85 °C; ^1H NMR δ 0.84 (t, J = 5.9 Hz, 3 H), 1.1–1.9 (m, 11 H), 2.1–2.6 (m, 1 H), 6.9–7.7 (m, 5 H), 8.49 (bs, 1 H); ^{13}C NMR δ 14.0, 18.0, 22.5, 27.2, 31.9, 34.5, 42.2, 120.4, 124.0, 128.7, 138.4, 176.0. Anal. Calcd for $C_{14}H_{21}NO$: C, 76.67; H, 9.65; N, 6.39. Found: C, 76.73; H, 9.64; N, 6.44. **34d**: 50%; PTLC (CH_2Cl_2); bulb-to-bulb distillation 160 °C, 0.6 mm; ^1H NMR δ 0.7–2.4 (b, 17 H), 6.9–7.7 (m, 5 H), 8.60 (bs, 1 H); ^{13}C NMR δ 12.0, 14.1, 22.6, 26.2, 27.4, 32.0, 33.0, 50.1, 120.6, 124.1, 128.7, 138.3, 175.3. Anal. Calcd for $C_{15}H_{23}NO$: C, 77.21; H, 9.93; N, 6.00. Found: C, 77.21; H, 9.94; N, 5.80.

Tandem Conjugate Addition–Peterson Olefination. Typical Procedure. *N*-Phenyl-2-pentylheptanamide. To a solution containing 1.5 mL (3.0 mmol) of 2.0 M *n*-BuMgCl in 6 mL of THF at −78 °C was added dropwise 222 mg (1.0 mmol) of **14a** in 3 mL of THF. After 1 min, the mixture was allowed to warm to 20 °C where it was kept for 2 h. The mixture was then cooled to −78 °C and treated with 0.32 mL (3 mmol) of freshly distilled pentanal. The solution was allowed to warm to 20 °C and then heated at 40–45 °C for 100 min. After solvent removal, the residue was treated with 10 mL of Et_2O and 10 mL of H_2O. The aqueous layer was acidified with 10% HCl to pH < 2 and twice more extracted with Et_2O. The extracts were washed with H_2O and then brine, dried (Na_2SO_4), and concentrated. PTLC (CH_2Cl_2) of the residue gave 67 mg (61%) of **36a** as a 1:1 mixture of *E*/*Z* isomers. The *E*-isomer contained a triplet at δ 6.25 (J = 7.3 Hz) and the *Z*-isomer a triplet of δ 5.50 for the olefinic proton in its ^1H NMR spectrum. Reduction of this mixture with H_2 (10 mg PtO_2, 2 mL EtOAc, 3 h at 1 atm H_2) gave 61 mg (92%) of *N*-phenyl-2-pentylheptanamide: mp 86.5–87.5 °C; ^1H NMR: δ 0.7–1.8 (m, 22 H), 2.1-2.4 (b, 1 H), 6.9–7.7 (m, 5 H), 8.02 (bs, 1 H); ^{13}C NMR d 14.0, 22.5, 27.4, 32.0, 33.3, 48.9, 120.3, 124.0, 128.8, 138.2, 175.0. Anal. Calcd for $C_{18}H_{29}NO$: C, 78.49; H, 10.61; N, 5.09. Found: C, 78.51; H, 10.79; N, 5.11. Similarly prepared was *N*-phenyl-2-benzylheptanamide: mp 97–98 °C (lit.[50] mp 98 °C).

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