Pergamon

Tetrahedron: *Asymmetry* 12 (2001) 439–454

TETRAHEDRON: *ASYMMETRY*

Synthesis of perhydroxazin-4-ones. Competitive Mukaiyama versus hetero Diels–Alder reaction in the cycloaddition of 2-aza-3-trimethylsilyloxy-1,3-butadiene and aldehydes

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Received 22 December 2000; accepted 1 February 2001

Abstract—The reactions of 2-aza-3-trimethylsilyloxy-1,3-butadiene with carbonyl dienophiles are described. 2-Aza-1,3-butadienes participate as dienes in the [4+2] cycloaddition with aldehydes to afford perhydroxazin-4-ones in good yields. Experimental results, however, show that a Mukaiyama type two-step reaction must be taken into account. The cycloadducts obtained have proved to be useful intermediates in the synthesis of α-amino-β-hydroxy acids.

1. Introduction

The hetero Diels–Alder (HDA) reaction using heterodienes and/or dienophiles is a very useful method for constructing heterocyclic rings and is widely used as a key step in the synthesis of natural products.[1–9] The use of activated dienes containing strongly electron-donating groups, such as 1-methoxy-3-trimethylsilyloxybutadiene, has added versatility to this synthetic method, opening the reaction to many useful applications since its introduction.[10] Ghosez reported on the synthesis and use of 2-aza-3-trialkylsilyloxy-1,3-dienes as useful intermediates in the HDA reaction for the preparation of heterocyclic compounds,[11–16] whilst Barluenga reported the use of azadienes, obtained from *N*-trimethylsilylimines, in the synthesis of nitrogen containing heterocycles.[17]

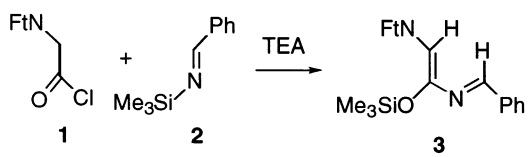
In conjunction with our current studies on *N*-trimethylsilylimines as useful tools for the preparation of biologically active compounds,[18] we have reported on the use of 2-aza-1,3-butadienes[14,16,19–22] for the synthesis of β-lactams,[23–28] tetramic,[29] and polyoxamic acids,[30] and for the generation of perhydroxazinones, useful precursors of β-hydroxy-α-amino acids as well as 2,2-disubstituted β-hydroxyacids.[29–33] Herein, we report the extension of our protocol to a range of aliphatic, aromatic and heteroaromatic aldehydes, with particular emphasis on the diastereoselectivity of the reaction.

2. Results

2.1. Synthesis of perhydroxazinones

2.1.1. Achiral azadiene. The first azadiene used was obtained from reaction between phthaloyl chloride **1** and *N*-trimethylsilyl benzaldimine[34] **2**. Scheme 1 illustrates the reported protocol for its synthesis.[23]

The (*E*,*Z*)-configuration and *s*-*cis*-conformation of **3** was determined by nOe experiments (see Section 5). Treatment of **3** with benzaldehyde **4** in the presence of a stoichiometric amount of boron trifluoride etherate (CH_2Cl_2, −78 to 20°C for 8 h) gave rise to cycloadducts **5**–**7** (Scheme 2). Adducts **5** and **6** had a C-(5)H/C-(6)H *cis*-configuration, as established by the relative coupling constant ($J = 5.15$ and 4.67 Hz, respectively), whereas **7**, with a C-(5)H/C-(6)H coupling constant of 10.46 Hz, was assigned a *trans*-configuration (Table 1).



Scheme 1.

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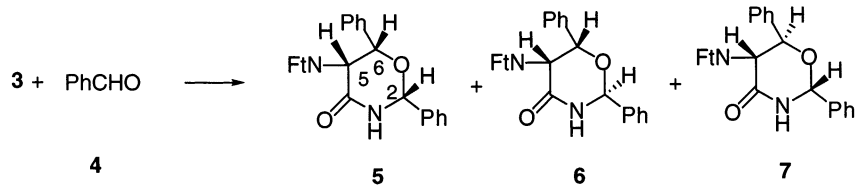


Scheme 2. Reagents and conditions: (i) $BF_3{\cdot}Et_2O$, −78°C, CH_2Cl_2.

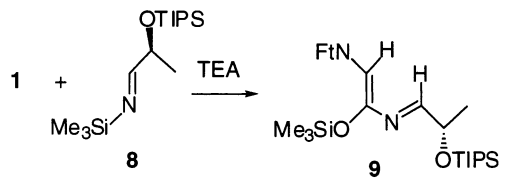
Table 1. Coupling constants (J in Hz) and nOe for compounds **5**–**7**

Products	J_{5-6} (Hz)	nOe	Yield % (ratio %)
5	5.1 (*cis*)	2→6; 5→6	30 (50)
6	4.7 (*cis*)	5→6	22 (36)
7	10.4 (*trans*)	–	8 (14)

It is important to underline that in Scheme 2, for the sake of simplicity, only one enantiomer for each couple is shown. For compound **5** nOe effects between C-(2)H/C-(6)H and C-(5)H/C-(6)H, respectively, are clear evidence that these protons lie on the same face of the diastereotopic plane. On this basis, for **5** the relative configuration depicted in Scheme 2 was assigned. Consequentially, the C-(5)H/C-(6)H *cis*-diastereomer **6** was attributed the relative configuration shown in Scheme 2. Finally, the lack of any nOe effect, coupled with the structural assignations of **5** and **6**, allowed the configuration of **7** to be established.

2.1.2. Single facial stereoinduction by a stereocentre present in the imine moiety. The next step of our study was to introduce a stereogenic centre in the azadiene starting from the chiral *N*-trimethylsilylimine **8**. The imine **8** was first obtained from reaction between the parent (*S*)-lactic aldehyde, protected on the hydroxy functionality as a triisopropylsilyl (TIPS) ether, and phthaloyl chloride **1**, as shown in Scheme 3.

The preparation of azadienes **9** has already been reported.[23] Upon reaction with benzaldehyde **4** and boron trifluoride etherate under the reported conditions, three cycloadducts **10**–**12** were obtained (Scheme 4).

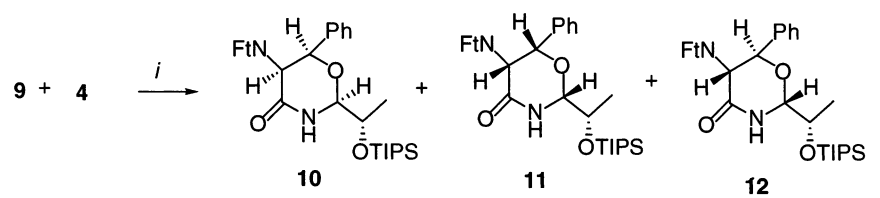


Scheme 3.

The cycloadducts **10** and **11** were assigned the C-(5)H/C-(6)H *cis*-configuration on the basis of their coupling constants of 5.64 and 4.64 Hz. Moreover, for compounds **10** and **11**, nOe experiments showed again the characteristic basket conformation of C-(2)H, C-(5)H and C-(6)H. The absolute configurations of C-(5) and C-(6) were attributed taking into account the absolute configuration of the C-(2) stereocentre. This configuration was established from the C-(2)H and C-(1′)H coupling constant and assumes that no epimerisation occurs at the C-(1′) stereocentre during the reaction.

A full AM1 conformational analysis[35] of the model diastereoisomers (*R*,*S*) and (*S*,*S*) shows that in both isomers the system is best described by the two conformations $(R,S)^3$ and $(S,S)^1$ in which a bonding interaction between the silyloxy oxygen and the amino group is operating (see Fig. 1). The coupling constant of the conformer $(S,S)^1$, with the two hydrogens *anti* to each other, was expected to be greater than that of the $(R,S)^3$-conformer, in which the two hydrogens have a *gauche*-relationship. The experimentally observed coupling constants of about 7 and 4 Hz, respectively (Table 2), allow the absolute configuration of the C-(2) stereocentres to be established. Since **10** presents a C-(2)H/C-(1′)H coupling constant of 7.76 Hz, the stereocentres must be (2*S*,1′*S*)-configured. From analysis of nOe effects (see Table 2) of the stereocentres of **10**, a (2*S*,5*S*,6*R*)-configuration was assigned. Compound **11** with a $J_{2-1'}$ coupling constant of 3.62 Hz was assigned the (2*R*,5*R*,6*R*)-configuration, and C-(5)H/C-(6)H *trans*-stereoisomer **12**, with a $J_{2-1'}$ of 4.10 Hz, must have a (2*R*,5*R*,6*R*)-absolute configuration.

2.1.3. Single facial stereoinduction by a stereocentre present in the acyl chloride moiety (Evans' chiral auxiliary). In order to explore all possible combinations between the two reactants in the preparation of azadiene (chiral/achiral acyl chloride and chiral/achiral imine, respectively), a new 3-silyloxy-2-aza-1,3-butadi-



Scheme 4. Reagents and conditions: (i) $BF_3{\cdot}Et_2O$, −78°C, CH_2Cl_2.

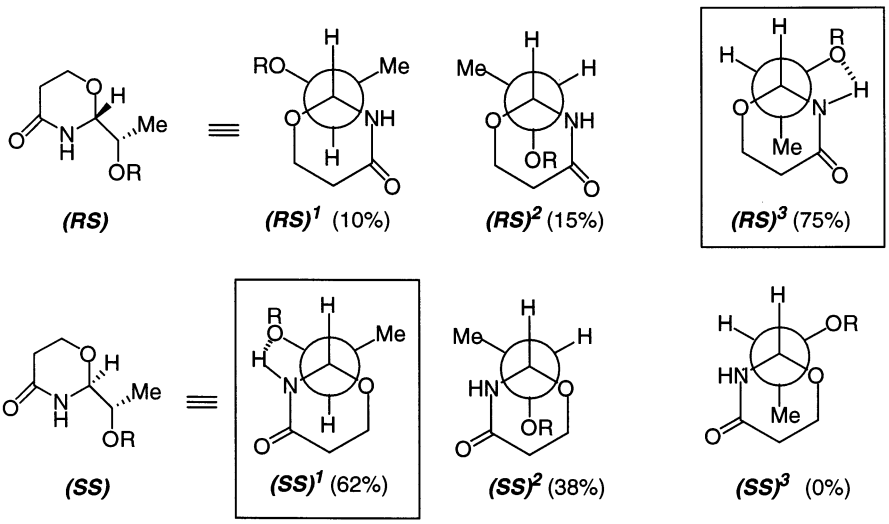


Figure 1. AM1 calculated percentage population of the (*R*,*S*)- and (*S*,*S*)-conformers.

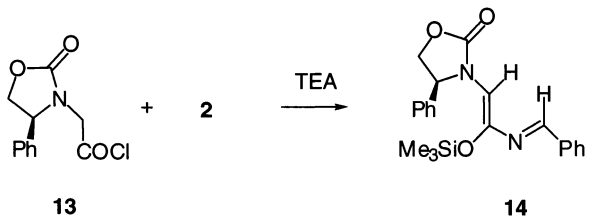
Table 2. Coupling constants (*J* in Hz) for C-(2)H, C-(5)H and C-(6)H for **10–12**

Products	$J_{2-1'}$ (Hz)	J_{5-6} (Hz)	nOe	Yield % (ratio %)
10	7.7 (*anti*)	4.6 (*cis*)	2→6; 5→6	8.5 (17)
11	3.6 (*syn*)	5.6 (*cis*)	6→2; 6→5	30 (60)
12	4.3 (*syn*)	9.8 (*trans*)	–	11.5 (23)

ene **14** was synthesised in a one-pot two-step procedure starting from benzaldehyde via the corresponding *N*-trialkylsilylbenzaldimine **2** and acyl chloride **13**.[36,37] Scheme 5 illustrates the protocol.

The azadiene **14** was then reacted with acetaldehyde **15** under the above conditions (Scheme 6).

Four stereoisomers were obtained: **16** and *epi*-**16** with a C-(5)H/C-(6)H *cis*-configuration ($J=5.88$ and 4.00 Hz, respectively), and **17** and *epi*-**17** presenting a C-(5)H/C-(6)H *trans*-configuration ($J=10.02$ and 9.90 Hz, respectively). From the results obtained in a previous paper,[33] we have demonstrated, via chemical correlation with the natural amino acid threonine, that Evans' chiral auxiliary induced (*R*)-configuration on the C-(5) stereocentre of the perhydroxazinone ring. A reasonable explanation for the observed induction may be given by analysing the preferential conformers arising from rotation along the oxazolidinone N–C-(2) bond of azadiene **14**.



13 **14**

Scheme 5.

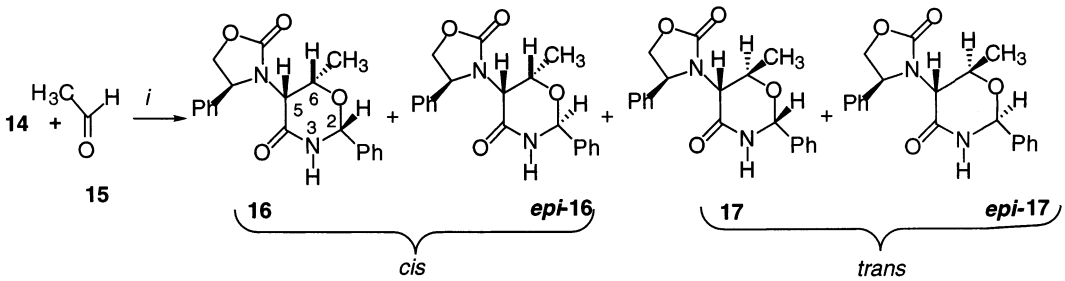
Full AM1 analysis[35] showed a preferential conformation in which the carbonyl group of Evans' oxazolidinone and the *O*-trimethylsilyl group are in an *anti*-position with a torsional angle of −150° (see Fig. 2). The dienophile is forced to attack from the opposite side of the diastereotopic plane in which the phenyl group of the oxazolidine–Evans' chiral auxiliary lies, thus inducing complete (*R*)-configuration on the C-(5)H (perhydroxazinone numbering) stereogenic centre. The absolute configuration of the C-(6)H and C-(2)H stereogenic centres was established by the C-(5)H/C-(6)H coupling constant of 4.00 Hz for **16**, and an nOe effect between C-(2)H and C-(6)H, which, correlated with the lack of any nOe effect between C-(2)H and the methyl protons on C-(6), allowed the assignment of the (2*R*,5*R*,6*S*)-configuration for **16**.

Consequently, since the epimeric *cis*-isomer shows an nOe effect between C-(2)H and the methyl group on C-(6), the configuration of *epi*-**16** can be established. Analogously, the presence or absence of nOe effects between C-(2)H and the methyl group on C-(6) in the *trans*-diastereoisomers allowed the stereochemistry of **17** and *epi*-**17** to be established. To fully confirm the configuration, acid hydrolysis of both **16** and *epi*-**16** with methanolic HCl afforded the same acid, **18**, with the same specific rotation (Scheme 7).

At this point, a systematic study using aldehydes **19** was performed (Scheme 8). Table 3 shows the results obtained.

Since 3-formyl-indole **19h** proved to be unreactive, the corresponding *N*-Boc-3-formyl-indole **19i** was prepared according to a literature procedure.[38] Reaction of **19i** with azadiene **14** gave rise to the *trans*-perhydroxazinones **21h** and *epi*-**21h** (Scheme 9).

The relative and absolute configurations of the stereogenic centres of the perhydroxazinones thus obtained were determined on the basis of the C-(5)H/C-(6)H coupling constants and nOe effects, if any, in analogy



Scheme 6. Reagents and conditions: (i) $BF_3{\cdot}Et_2O$, −78°C, CH_2Cl_2.

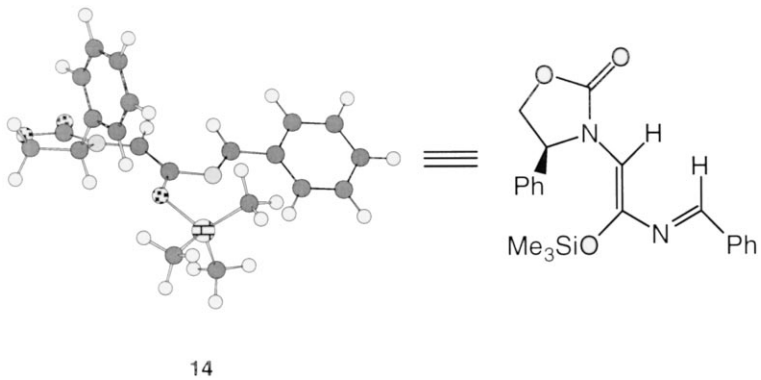
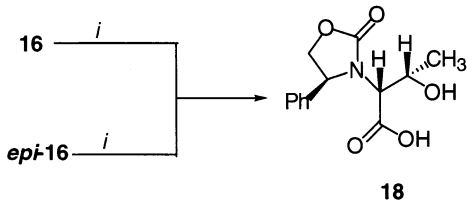


Figure 2. AM1 calculated preferential conformation of **16**.

to that previously discussed. In the aromatic series, fundamentally, the presence or absence of an nOe effect between C-(2)H and C-(6)H allowed the direct identification of **21** and *epi*-**21**. The coupling constants and the nOe effects for the diagnostic protons are shown in Table 4.

As the data show, the C-(5) stereogenic centre formation is under stereochemical control, whereas the stereochemical control in the formation of the C-(2) and C-(6) stereogenic centres depends on the very nature of the aldehyde dienophiles. Generally speaking with aldehydes bearing alkyl substituents, C-(5)H/C-(6)H *cis*-diastereoselectivity predominates, whereas with aromatic and heteroaromatic substituents, C-(5)H/C-(6)H *trans*-diastereoselection is preferred. Among the alkyl groups, the straight chain groups provided the greatest degree of *cis*-diastereoselection (Table 3, entries 2 and 4) and the increase in steric requirements from methyl to propyl and heptyl groups had no dramatic effect on the diastereoselectivity of the reaction. The presence of branched side chains was found to be more important: an isopropyl group gave rise to an inversion of diastereoselectivity (*cis*/*trans* ratio of 3/7; Table 3, entry 3). No cycloadducts were obtained with the hindered *tert*-butyl group (use of pivaldehyde as dienophile). It must be stressed that the two *trans*-diastereomers are different only in the absolute configuration of the C-(2) stereocentre.

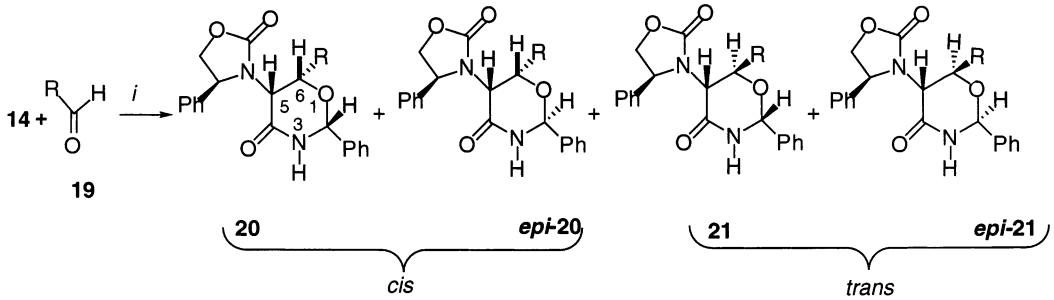


Scheme 7. Reagents and conditions: (i) MeOH/HCl.

2.1.4. Double stereoinduction by two stereocentres present in the acyl chloride and imine moieties. The last set of experiments concerned the use of homochiral imines and homochiral acyl chlorides in the formation of the azadiene. In order to achieve better control in the formation of the C-(2), C-(5) and C-(6) stereogenic centres, and using the positive results from the double stereoinduction in the synthesis of β-lactams from azadienes,[24] two chiral centres were introduced into the azadiene moiety by means of the *N*-trimethylsilylimine of 2-(triisopropylsilyloxy)lactaldehyde **8** and Evans' chiral auxiliary. The corresponding azadiene **22** was prepared according to the usual protocol (Scheme 10).[24]

Reaction of azadiene **22** with a range of aliphatic, aromatic and heteroaromatic aldehydes **19** using boron trifluoride etherate in dichloromethane at −78 to 20°C over 8 h (Scheme 11) gave rise to *cis*-/*trans*-diastereoisomers in the yields and diastereomeric ratios reported in Table 5.

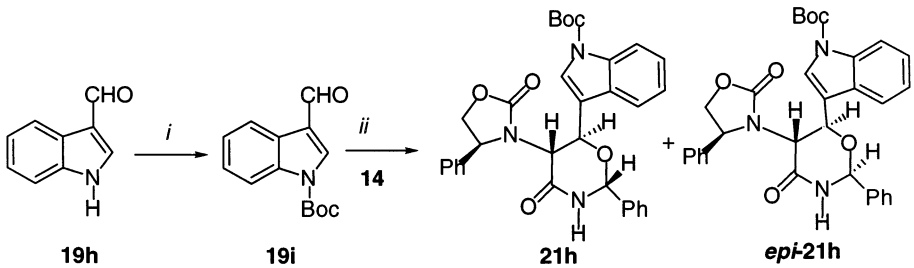
In contrast to the results obtained using azadiene **13**, both aliphatic and aromatic aldehydes gave rise to two diastereoisomers presenting either a *cis*- or *trans*-configuration on the C-(5)/C-(6) stereogenic centres. No other isomers were detected in the crude reaction mixtures. Table 6 reports the coupling constants between



Scheme 8. Reagents and conditions: (i) $BF_3{\cdot}Et_2O$, −78°C, CH_2Cl_2. **19a**, **20a**, **21a**: R = C_3H_7; **19b**, **20b**, **21b**: R = *i*-Pr; **19c**, **20c**, **21c**: R = heptyl; **19d**, **20d**, **21d**: R = phenyl; **19e**, **20e**, **21e**: R = *p*-MeO-Ph; **19f**, **20f**, **21f**: R = *p*-NO_2-Ph; **19g**, **20g**, **21g**: R = 2-naphthyl; **19i**, **20h**, **21h**: R = 3-(*N*-Boc)-indolenyl.

Table 3. Perhydroxazinone from azadiene **14** and aldehydes **15** and **19**

Entry	Aldehyde	R	Products	Total yield % (ratio %)
1	**15**	Methyl	**16**/*epi*-**16**; **17**/*epi*-**17**	38 (36/20/18/26)
2	**19a**	*n*-Propyl	**20a**/*epi*-**20a**; **21a**/*epi*-**21a**	65 (78/0/3/19)
3	**19b**	*i*-Propyl	**20b**/*epi*-**20b**; **21b**/*epi*-**21b**	54 (0/30/16/54)
4	**19c**	Heptyl	**20c**/*epi*-**20c**; **21c**/*epi*-**21c**	59 (75/0/4/21)
5	**19d**	Phenyl	**20d**/*epi*-**20d**; **21d**/*epi*-**21d**	52 (0/0/43/57)
6	**19e**	*p*-MeO-Phenyl	**20e**/*epi*-**20e**; **21e**/*epi*-**21e**	30 (0/0/83/17)
7	**19f**	*p*-NO_2-Phenyl	**20f**/*epi*-**20f**; **21f**/*epi*-**21f**	45 (0/0/87/13)
8	**19g**	Naphthyl	**20g**/*epi*-**20g**; **21g**/*epi*-**21g**	57 (0/0/84/16)
9	**19i**	3-(*N*-Boc)-Indolenyl	**20h**/*epi*-**20h**; **21h**/*epi*-**21h**	62 (0/0/82/18)



Scheme 9. Reagents and conditions: (i) Di-*t*-butyl-pyrocarbonate, TEA, $DMAP_{cat.}$; (ii) $BF_3{\cdot}Et_2O$, −78°C, CH_2Cl_2.

diagnostic protons and nOe, if any. It is noteworthy that for the *trans*-isomers an nOe between C-(2)H and C-(5)H is observed, in accord with the configuration assigned to the perhydroxazin-2-one **24**.

The nOe effect between C-(2)H and C-(5)H may result from a boat conformation of the six-membered ring in which all three bulky substituents are oriented equatorially. Fig. 3 shows the proximity of the C-(2) and C-(5) protons.

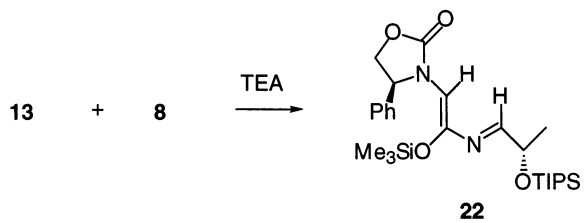
3. Discussion

Diastereoselection in pericyclic reactions has been explained in terms of *exo*-/*endo*-transition states depending on the Lewis acid (LA) and the steric demands of the substituents on the dienophile. A pericyclic pathway (a) predominates with LAs such as $ZnCl_2$, $Eu(fod)_3$ and $MgBr_2$. These coordinate the aldehyde oxygen *syn* to the hydrogen and force the R^1 group into an *endo*-position in the transition state (TS), leading to the *cis*-(2*R*,5*R*,6*S*)-products (Scheme 12, pathway (a)). Aldehydes having R^1 groups larger than the coordinating LA can react via a pericyclic *exo*-mode affording *trans*-(2*R*,5*R*,6*R*)-products (Scheme 12, pathway (b)).

The HDA reaction was expected to produce *endo*- or *exo*-products in which a *cis*-relationship is established between C-(2)H and C-(5)H. However, analysis of the reaction mixture shows the presence of diastereoisomers with a *trans*-relationship between C-(2)H and C-(5)H. There are two possible explanations for the formation of C-(2)/C-(5) *trans*-products: the first involves epimerisation of the C-(2) and/or C-(5) stereogenic centres during the reaction; alternatively, a stepwise Mukaiyama mechanism may be occurring. The first hypothesis is unlikely, in our opinion, since in a previous case[24] quenching the reaction mixture at −78°C

Table 4. Coupling constants (J in Hz) for C-(5)H and C-(6)H and nOe

Entry	R	Products	J_{5-6} (Hz)	nOe
1	Methyl	**16**	4.0 (*cis*)	2→6; 5→6
2	Methyl	*epi*-**16**	5.9 (*cis*)	CH_3→2; 5→6
3	Methyl	**17**	9.9 (*trans*)	–
4	Methyl	*epi*-**17**	10.0 (*trans*)	2→6
5	Propyl	**20a**	3.9 (*cis*)	2→6; 5→6
6	Propyl	*epi*-**21a**	10.1 (*trans*)	2→6
7	*i*-Propyl	*epi*-**20b**	2.8 (*cis*)	5→6
8	*i*-Propyl	**21b**	10.3 (*trans*)	–
9	*i*-Propyl	*epi*-**21b**	10.5 (*trans*)	2→6
10	Hepthyl	**20c**	4.0 (*cis*)	2→6; 5→6
11	Hepthyl	*epi*-**21c**	10.0 (*trans*)	2→6
12	Phenyl	**21d**	10.2 (*trans*)	–
13	Phenyl	*epi*-**21d**	9.6 (*trans*)	2→6
14	*p*-MeO-Phenyl	**21e**	10.0 (*trans*)	–
15	*p*-MeO-Phenyl	*epi*-**21e**	10.0 (*trans*)	2→6
16	*p*-NO_2-Phenyl	**21f**	10.0 (*trans*)	–
17	*p*-NO_2-Phenyl	*epi*-**21f**	10.4 (*trans*)	2→6
18	2-Naphthyl	**21g**	10.0 (*trans*)	–
19	2-Naphthyl	*epi*-**21g**	10.2 (*trans*)	2→6
20	*N*-Boc-3-Indolenyl	**21h**	10.0 (*trans*)	–
21	*N*-Boc-3-Indolenyl	*epi*-**21h**	10.2 (*trans*)	2→6



Scheme 10.

after 3 h led to a decrease in yield but did not affect the diastereomeric ratio of the perhydroxazin-2-ones. The second hypothesis of a stepwise mechanism, competitive with the classical HDA mechanism, is more likely. In fact, formulation in terms of the Mukaiyama silyl enol–ether aldol process leads to intermediates **I-2** and **I-3** (Scheme 12, pathways (c) and (d)), which, upon ring closure, give rise to *cis*-(2*R*,5*R*,6*S*)- and/or *cis*-(2*S*,5*R*,6*S*)- and *trans*-(2*S*,5*R*,6*R*)- and/or *trans*-(2*R*,5*R*,6*R*)-products.

The experimental evidence suggests that Mukaiyama-like processes, responsible for the formation of C–C and C–O bonds, are discrete, which gives rise to the possibility of isolating and identifying the intermediates. Studies directed towards the isolation and identification of an open chain product are currently underway. In the light of our above reported experimental results, it is reasonable that both mechanisms, concerted HDA reaction and step-by-step Mukaiyama reaction, may be operating in determining the diastereomeric ratio of the products.

4. Conclusions

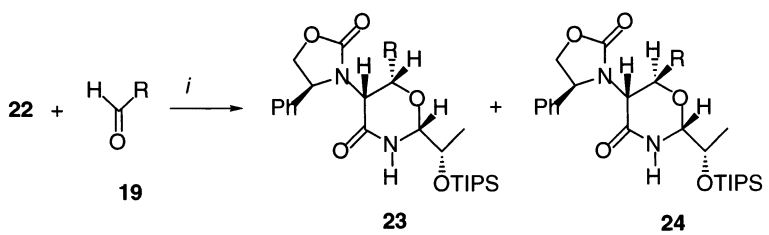
Boron trifluoride-mediated cycloaddition of aldehydes and 2-aza-3-trimethylsilyloxy-1,3-diene produces adducts that may arise from a classical HDA reaction or from a Mukaiyama aldol type reaction. The competitive existence of both reaction pathways has been demonstrated by the stereochemical analysis of the products. The degree of diastereoselection in both mechanisms appears to be dependent upon the steric and electronic nature of the dienophile and the diene used.

The optimal conditions for the reaction were found to be with the diene carrying two chiral auxiliaries, and, under these conditions, the reactions take place with high control of the diastereoselectivity. Studies on the use of different Lewis acids under catalytic conditions are currently under examination and will be reported in due course. Finally, it has been demonstrated by us[33] and other research groups[11,12] that the resulting perhydroxazinones provide a scaffold for other synthetic transformations and can be used to prepare proteinogenic and non-proteinogenic amino acids in enantiomerically pure forms.

5. Experimental

5.1. General

Melting points were taken on a Mel-Temp apparatus and are uncorrected. ^1H and ^{13}C NMR spectra were recorded in $CDCl_3$ on a Varian Gemini 200 spectrometer. Chemical shifts are reported in the δ scale and coupling constants (J) are reported in hertz. The values of diagnostic protons and carbons are reported in



Scheme 11. Reagents and conditions: (i) $BF_3{\cdot}Et_2O$, −78°C, CH_2Cl_2. **19a**, **23a**, **24a**: R = *n*-propyl; **19b**, **23b**, **24b**: R = *i*-Pr; **19c**, **23c**, **24c**: R = heptyl; **19d**, **23d**, **24d**: R = phenyl; **19e**, **23e**, **24e**: R = *p*-MeO-Ph; **19i**, **23f**, **24f**: R = 3-(*N*-Boc)-indolenyl; **19j**, **23g**, **24g**: R = cyclohexyl; **19k**, **23h**, **24h**: R = C_2H_5; **19l**, **23i**, **24i**: R = 3-pyridyl; **19m**, **23j**, **24j**: R = 2-thienyl; **19n**, **23k**, **24k**: R = 2-furyl.

Table 5. Perhydroxazinone from azadiene **22** and aldehydes **19**

Entry	Aldehyde	R	Products	Ratio *cis*/*trans*	Yield (%)
1	**19a**	*n*-Propyl	**23a**/**24a**	85/15	50
2	**19b**	*i*-Propyl	**23b**/**24b**	35/65	27
3	**19c**	*n*-Hepthyl	**23c**/**24c**	86/14	55
4	**19d**	Phenyl	**23d**/**24d**	26/74	54
5	**19e**	*p*-MeO-Phenyl	**23e**/**24e**	27/73	50
6	**19i**	3-(*N*-Boc)-Indolenyl	**23f**/**24f**	2/98	50
7	**19j**	Cyclohexyl	**23g**/**24g**	31/69	42
8	**19k**	Ethyl	**23h**/**24h**	86/14	51
9	**19l**	3-Pyridyl	**23i**/**24i**	28/72	42
10	**19m**	2-Thienyl	**23j**/**24j**	50/50	59
11	**19n**	2-Furyl	**23k**/**24k**	58/42	68

Table 6. Coupling constants (J in Hz) for C-(2)H/C-(1′)H and C-(5)H/C-(6)H for **23** and **24** and nOe

Entry	R	Product	$J_{2-2'}$	J_{5-6}	nOe
1	*n*-Propyl	**23a**	3.6 (*syn*)	4.8 (*cis*)	2→6; 5→6
2	*n*-Propyl	**24a**	4.0 (*syn*)	8.5 (*trans*)	2→5
3	*i*-Propyl	**23b**	3.8 (*syn*)	3.8 (*cis*)	2→6; 5→6
4	*i*-Propyl	**24b**	3.8 (*syn*)	8.9 (*trans*)	2→5
5	*n*-Hepthyl	**23c**	3.7 (*syn*)	4.4 (*cis*)	2→6; 5→6
6	*n*-Hepthyl	**24c**	4.0 (*syn*)	8.4 (*trans*)	2→5
7	Phenyl	**23d**	3.7 (*syn*)	5.3 (*cis*)	2→6; 5→6
8	Phenyl	**24d**	4.5 (*syn*)	9.6 (*trans*)	2→5
9	*p*-MeO-Phenyl	**23e**	3.6 (*syn*)	5.1 (*cis*)	2→6; 5→6
10	*p*-MeO-Phenyl	**24e**	4.3 (*syn*)	9.6 (*trans*)	2→5
11	3-(*N*-Boc)-Indolenyl	**24f**	4.5 (*syn*)	9.3 (*trans*)	2→5
12	Cyclohexyl	**23g**	3.8 (*syn*)	3.7 (*cis*)	2→6; 5→6
13	Cyclohexyl	**24g**	4.0 (*syn*)	9.1 (*trans*)	2→5
14	Ethyl	**23h**	3.7 (*syn*)	4.4 (*cis*)	2→6; 5→6
15	Ethyl	**24h**	4.0 (*syn*)	8.5 (*trans*)	2→5
16	3-Pyridyl	**23i**	3.2 (*syn*)	4.2 (*cis*)	5→6
17	3-Pyridyl	**24i**	4.7 (*syn*)	9.8 (*trans*)	2→5
18	2-Thienyl	**23j**	3.8 (*syn*)	5.2 (*cis*)	2→6; 5→6
19	2-Thienyl	**24j**	4.4 (*syn*)	9.2 (*trans*)	2→5
20	2-Furyl	**23k**	3.6 (*syn*)	4.4 (*cis*)	2→6; 5→6
21	2-Furyl	**24k**	4.4 (*syn*)	9.2 (*trans*)	2→5

brackets. Infrared spectra were recorded as Nujol mulls on a Nicolet 205 FT-IR spectrophotometer. Specific rotation measurements were carried out on a Perkin–Elmer 343 polarimeter and specific rotation $[\alpha]_D^{20}$ is reported in deg per dm^3 at the specified temperature and with the concentration [c] given in g per 100 mL in $CHCl_3$. THF, toluene, and heptane were distilled from benzophenone ketyl. Lithium bis(trimethylsilyl)amide (LiHMSDA) (1 M solution in hexane) was purchased from Lancaster Synthesis.

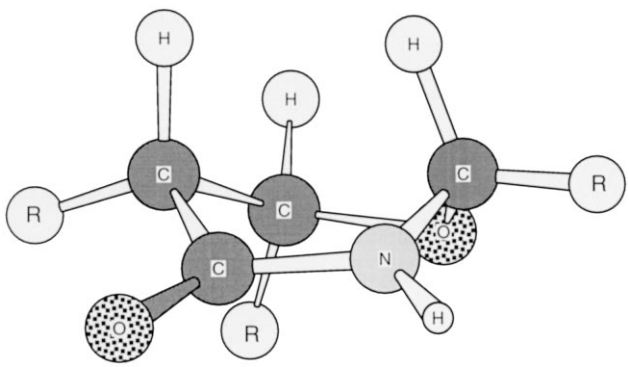


Figure 3. Boat conformation of the model 2,5,6-equatorial substituted perhydroxazin-2-one.

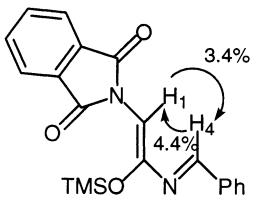
5.2. Materials

N-Trialkylsilylimines were prepared according to reported procedures[18] starting from the parent aldehydes. Triethylamine was dried over KOH. Other solvents and reagents were obtained commercially and were used as received. All reactions were performed under nitrogen, on a 1.0 mmol scale, and the yields reported refer to the whole process (starting from the aldehyde used in the preparation of the imine).

5.3. Preparation of 1-phthalimido-2(trimethylsilyl)oxy-3-aza-4-phenyl-1,3-butadiene 3

A solution of benzaldehyde (0.1 mL, 1 mmol) in heptane (2 mL) was added to a solution of LiHMDSA (1 M in hexane, 1 mL) in heptane (5 mL) previously

cooled to 0°C. The reaction mixture was stirred at 0°C for 1 h. Imine formation was confirmed by IR analysis ($\nu_{CN}=1655$ cm^{-1}). Trimethylsilyl chloride (0.13 mL, 1 mmol) was added in one portion. After stirring for 10 min at 0°C, the mixture was allowed to stir for 1 h at rt wherein a white precipitate formed. The mixture was cooled to 0°C and triethylamine (0.3 mL, 2 mmol) was added in one portion and the mixture stirred for 5 min. Phthalimidoyl chloride (0.22 g, 1 mmol) dissolved in toluene (5 mL) was added dropwise and the resultant mixture stirred for 1 h wherein a thick precipitate formed. The mixture was filtered through Celite under argon and the solvent was removed from the filtrate in vacuo to afford an oil, which was analysed by ^{1}H NMR spectroscopy. Structure **3** shows the nOe between the C-(1)H and C-(4)H diagnostic protons. IR ($CHCl_3$): 1721, 1687; ^{1}H NMR: 8.57 (s, 1H, C-(4)H), 7.88 (m, 4H), 7.75 (m, 2H), 7.47 (m, 3H), 5.92 (s, 1H, C-(1)H), 0.16 (s, 9H); ^{13}C NMR: 166.76 (C_1), 158.38, 154.62, 134.09 (C_2), 132.20, 131.80, 130.078, 129.17, 128.77, 123.39, 95.08 (C_4), 0.283.

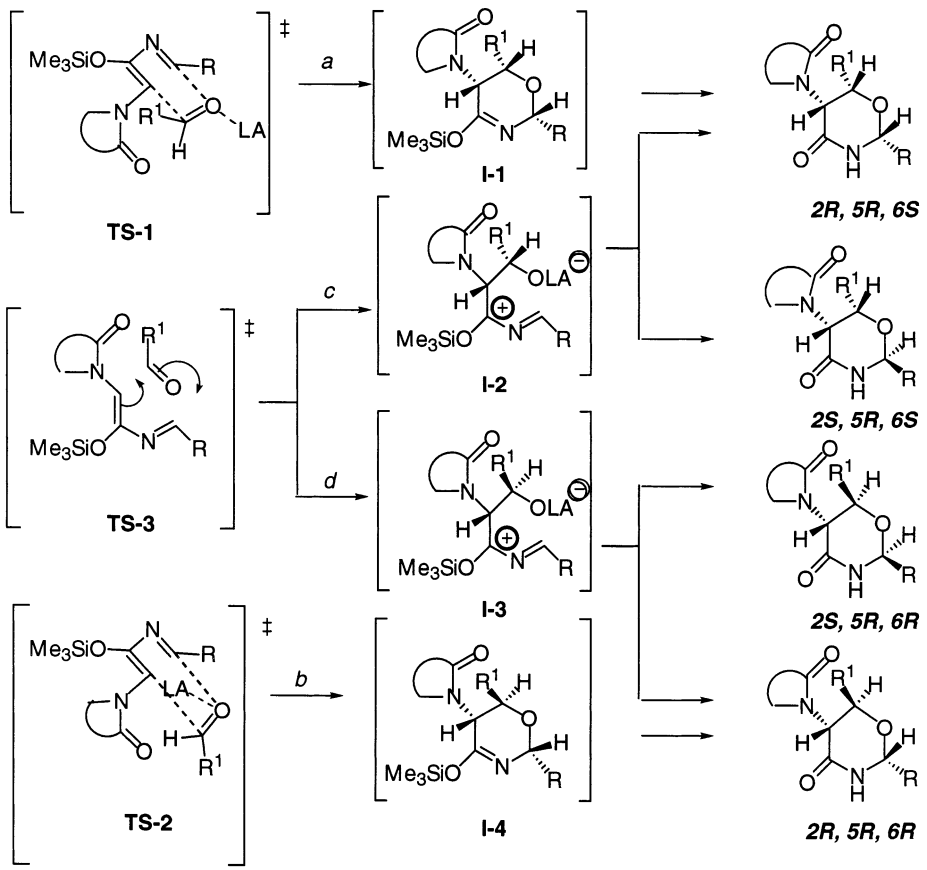


3

5.4. General procedure for the preparation of perhydroxazin-4-ones 5–7

Azadiene **3**, prepared as reported above, was dissolved in dichloromethane (5 mL). The solution was cooled to −78°C and benzaldehyde (0.11 mL, 1 mmol) in dichloromethane (2 mL) was added, followed by the very slow addition of boron trifluoride diethyl etherate (0.13 mL, 1 mmol) dissolved in dichloromethane (10 mL). The reaction was stirred at −78°C for 3 h and allowed to warm to rt overnight. The crude reaction mixture was diluted with dichloromethane (10 mL), poured into saturated aqueous $NaHCO_3$ solution, and extracted further with dichloromethane. The organic layers were washed with brine, and then dried over $MgSO_4$. After filtration, the solvent was removed under reduced pressure and the crude reaction mixture was purified by flash chromatography on silica gel, eluting with dichloromethane/acetone 9/1. Compounds **5–7** were obtained in 63% overall yield in a 50/36/14 diastereomeric ratio as oils. Spectral data for each compound are as follows.

5.4.1. (2*R,5*R**,6*S**)-2-Phenyl-5-phthalimido-6-phenyl-1,3-oxazinan-4-one 5**. IR ($CHCl_3$): 1721, 1687; ^{1}H NMR: 7.90–7.10 (m, 14H), 6.68 (s, 1H, NH), 6.00 (s, 1H, C-(2)H), 5.42 (d, 1H, $J=5.1$, C-(5)H), 5.14 (d, 1H, $J=5.1$, C-(6)H); ^{13}C NMR: 166.81 (C_4), 164.57, 137.52, 135.39, 133.93, 130.27, 129.03, 128.17, 127.67, 125.79, 123.26, 86.82 (C_2), 80.23 (C_6), 52.06 (C_5); MS m/z: 398



Scheme 12.

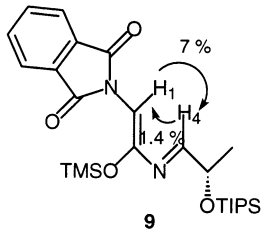
(M^+), 292, 249, 187, 145. Anal. calcd for $C_{24}H_{18}N_2O_4$: C, 72.35; H, 4.55; N, 7.03. Found: C, 72.51; H, 4.51; N, 6.9%.

5.4.2. (2*S,5*R**,6*S**)-2-Phenyl-5-phthalimido-6-phenyl-1,3-oxazinan-4-one 6**. IR ($CHCl_3$): 1721, 1687; ^1H NMR: 7.70–7.10 (m, 15H), 6.52 (d, 1H, $J=3.1$, C-(2)H), 5.21 (d, 1H, $J=4.7$, C-(5)H), 5.02 (d, 1H, $J=4.7$, C-(6)H); ^{13}C NMR: 167.09 (C_4), 165.70, 137.69, 135.40, 133.98, 131.38, 129.44, 128.94, 128.10, 126.92, 125.97, 125.29, 83.12 (C_2), 72.76 (C_6), 52.84 (C_5); MS m/z: 398 (M^+), 292, 249, 187, 145. Anal. calcd for $C_{24}H_{18}N_2O_4$: C, 72.35; H, 4.55; N, 7.03. Found: C, 72.23; H, 4.58; N, 7.18%.

5.4.3. (2*R,5*R**,6*R**)-2-Phenyl-5-phthalimido-6-phenyl-1,3-oxazinan-4-one 7**. IR ($CHCl_3$): 1721, 1692; ^1H NMR: 7.80–7.20 (m, 14H), 7.12 (s, 1H), 6.28 (d, 1H, $J=2.0$, C-(2)H), 5.34 (d, 1H, $J=10.5$, C-(5)H), 5.08 (d, 1H, $J=10.5$, C-(6)H); ^{13}C NMR: 166.42 (C_4), 137.72, 136.37, 134.15, 131.52, 129.55, 129.03, 128.80, 128.67, 127.45, 127.02, 123.62, 83.68 (C_2), 69.95 (C_6), 53.51 (C_5); MS m/z: 398 (M^+), 292, 249, 187, 145. Anal. calcd for $C_{24}H_{18}N_2O_4$: C, 72.35; H, 4.55; N, 7.03. Found: C, 72.57; H, 4.53; N, 6.87%.

5.5. Preparation of (5*S*)-1-phthalimido-2(trimethylsilyl)-oxy-3-aza-5-triisopropylsilyloxyhexa-1,3-diene 9

A solution of (*S*)-lactimine **8** was prepared by the dropwise addition of a heptane solution (5 mL) of (*S*)-1-triisopropylsiloxylactaldehyde (0.23 g, 1 mmol) to a cooled (0°C) hexane solution of lithium bis(trimethyldisilyl)amide (LiHMDSA) (1 mL of 1 M soln in heptane). After addition of the aldehyde, the reaction mixture was stirred at 0°C for 1 h. Imine formation was confirmed by IR analysis of the reaction mixture ($\nu_{CN}=1685\ cm^{-1}$). To the imine solution, trimethylsilyl chloride (0.13 mL, 1 mmol) was added in one portion, and the mixture allowed to stir at 0°C for 15 min and for a further 1 h at rt. The mixture was cooled to 0°C and triethylamine (0.3 mL, 2.0 mmol) was added in one portion, and the mixture stirred for 5 min at 0°C. A solution of phthaloyl chloride (0.22 g, 1 mmol) in toluene was added very slowly (over 5 min). Stirring was maintained for 30 min at 0°C and a further 1 h at rt. The yellow–orange mixture was filtered through Celite and the solvent was removed in vacuo. A sample was removed from the reaction mixture, concentrated to an oil, and analysed by ^1H NMR to check for the presence of the azadiene species **9**. IR ($CHCl_3$): 1721, 1687; ^1H NMR: 7.92 (d, 1H, $J=4.8$, C-(4)H), 7.86 (m, 2H), 7.72 (m, 2H), 5.74 (s, 1H, C-(1)H), 4.52 (dq, 1H, $J=4.8$, 6.8, C-(5)H), 1.35 (d, 3H, $J=6.8$), 1.04 (m, 21H), 0.08 (s, 9H); ^{13}C NMR: 167.44, 166.68 (C_4), 153.62 (C_2), 134.11, 132.14, 123.39, 95.71 (C_1), 70.50 (C_5), 21.98, 17.93, 17.66, 12.23, 0.16.



9

5.6. Preparation of perhydroxazin-4-ones 10–12

A solution of azadiene **9** in dichloromethane (5 mL), cooled at −78°C, and benzaldehyde (0.11 mL, 1 mmol) in methylene chloride (2 mL) was added followed by very slow addition of boron trifluoride diethyl etherate (0.13 mL, 1 mmol) dissolved in methylene chloride (10 mL). The reaction was stirred at −78°C for 3 h and then allowed to warm to rt overnight. The crude reaction mixture was diluted with dichloromethane (10 mL), poured into a saturated aqueous $NaHCO_3$ solution, and extracted with dichloromethane. The organic extracts were combined, washed with brine and dried over $MgSO_4$. After filtration, the solvent was removed under reduced pressure and the crude reaction mixture purified by flash chromatography on silica gel, eluting with dichloromethane/acetone 9/1. Compounds **10–12** were obtained in 50% overall yield and a 60/17/23 diastereomeric ratio. Spectral data are as follows.

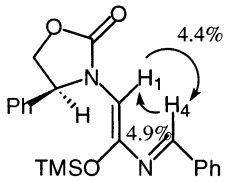
5.6.1. (2*S*,5*S*,6*R*)-6-Phenyl-5-phthalimido-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 10. $[\alpha]_D^{20}=-104.7$ (*c* 0.64, $CHCl_3$); IR ($CHCl_3$): 1722, 1686; ^1H NMR: 7.70 (m, 4H), 7.25 (m, 5H), 6.98 (s, 1H, NH), 5.22 (d, 1H, $J=4.6$, C-(5)H), 5.03 (d, 1H, $J=4.6$, C-(6)H), 4.74 (d, 1H, $J=7.8$, C-(2)H), 4.35 (m, 1H, C-(1′)H), 1.38 (d, 3H, $J=6.1$), 1.18 (s, 21H); ^{13}C NMR: 164.04 (C_4), 135.53, 133.81, 128.16, 125.71, 123.21, 87.83 (C_3), 79.37 (C_6), 71.06 ($C_{1'}$), 52.73 (C_5), 19.85, 18.20, 18.12, 12.75; MS m/z: 523 (M^++1), 479 (M^+−43), 373, 321, 276, 250, 187. Anal. calcd for $C_{29}H_{38}N_2O_5Si$: C, 66.64; H, 7.33; N, 5.36. Found: C, 66.74; H, 7.30; N, 5.53%.

5.6.2. (2*R*,5*R*,6*S*)-6-Phenyl-5-phthalimido-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 11. $[\alpha]_D^{20}=+93.7$ (*c* 0.44, $CHCl_3$); IR ($CHCl_3$): 1722, 1684; ^1H NMR: 7.65 (m, 4H), 7.20 (m, 5H), 6.85 (s, 1H), 5.30 (d, 1H, $J=5.6$, C-(5)H), 5.16 (d, 1H, $J=3.6$, C-(2)H), 5.12 (d, 1H, $J=5.6$, C-(6)H), 4.32 (dq, 1H, $J=3.6$, 6.2, C-(1′)H), 1.54 (d, 3H, $J=6.2$), 1.08 (s, 21H); ^{13}C NMR: 164.88 (C_4), 135.40, 133.87, 128.19, 125.70, 123.17, 85.54 (C_3), 80.15 (C_6), 68.88 ($C_{1'}$), 52.33 (C_5), 18.04, 18.00, 16.37, 12.20; MS m/z: 523 (M^++1), 479 (M^+−43), 373, 321, 276, 250, 187. Anal. calcd for $C_{29}H_{38}N_2O_5Si$: C, 66.64; H, 7.33; N, 5.36. Found: C, 66.40; H, 7.36; N, 5.53%.

5.6.3. (2*R*,5*R*,6*R*)-6-Phenyl-5-phthalimido-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 12. ^1H NMR: 7.65 (m, 4H), 7.20 (m, 5H), 6.60 (s, 1H, NH), 5.66 (d, 1H, $J=9.8$, C-(5)H), 5.28 (d, 1H, $J=4.3$, C-(2)H), 5.02 (d, 1H, $J=9.8$, C_6H), 4.22 (m, 1H, C-(1′)H), 1.38 (d, 3H, $J=6.1$), 1.05 (s, 21H); ^{13}C NMR: 154.81 (C_4), 139.38, 134.10, 128.71, 126.96, 123.56, 83.70 (C_3), 73.07 (C_6), 69.51 ($C_{1'}$), 53.95 (C_5), 18.02, 17.98, 17.50, 12.18.

5.7. 1-[(4*S*)-2-Oxo-4-phenyloxazolidin-3-yl]-2-trimethylsilyloxy-3-aza-4-phenylbuta-1,3-diene 14

To a solution of imine **2**, prepared as above, cooled at 0°C, triethylamine (0.3 mL, 2 mmol) was added in one portion. After stirring for 5 min, a solution of the acid chloride **13** (prepared from the corresponding acid (0.26 g, 1.2 mmol) and oxalyl chloride (0.16 mL, 1.8 mmol) according to the literature procedure[36,37]) in dry toluene (5 mL) was added dropwise. Stirring was maintained for 1 h wherein a thick precipitate formed. The precipitate was filtered through Celite under argon and the solvent was removed in vacuo. The oil obtained was analysed by NMR spectroscopy. ^{1}H NMR: 8.20 (s, 1H, C-(4)H), 7.68 (m, 2H), 7.40–7.10 (m, 8H), 6.02 (s, 1H, C-(1)H), 5.46 (dd, 1H, $J=3.4$, 8.0), 4.66 (t, 1H, $J=8.5$), 4.24 (dd, 1H, $J=3.4$, 8.5), 0.25 (s, 9H); ^{13}C NMR: 156.66 (C_4), 154.78, 139.36 (C_2), 135.53, 131.22, 130.09, 128.98, 128.68, 128.61, 126.21, 100.09 (C_1), 70.24, 59.48, 0.62.



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5.8. Preparation of perhydroxazin-4-ones 16, *epi*-16, 17 and *epi*-17

Following the procedure reported for compounds **10**–**12**, perhydroxazin-4-ones **16**, *epi*-**16**, **17**, and *epi*-**17** were obtained starting from azadiene **14** and acetaldehyde in 38% yield and a 36/20/18/26 diastereomeric ratio. Spectral data for these compounds are as follows.

5.8.1. (2*R*,5*R*,6*S*)-6-Methyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 16. $[\alpha]_D^{20}=+132.89$ (*c* 0.90, $CHCl_3$); IR ($CHCl_3$): 1754, 1686; ^{1}H NMR: 7.30 (m, 10H), 5.98 (s, 1H, NH), 5.68 (s, 1H, C-(2)H), 5.20 (dd, 1H, $J=6.8$, 8.8), 4.64 (t, 1H, $J=8.8$), 4.32 (d, 1H, $J=4.0$, C-(5)H), 4.16 (m, 2H, C-(6)H), 1.38 (d, 3H, $J=6.5$); ^{13}C NMR: 165.85 (C_4), 159.12, 137.27, 136.76, 129.95, 129.11, 128.78, 127.87, 126.81, 86.09 (C_2), 75.32 (C_6), 70.73, 61.32 (C_5), 55.53, 16.50; MS *m*/*z*: 352 (M^+), 308, 203, 191, 176, 145, 104. Anal. calcd for $C_{20}H_{20}N_2O_4$: C, 68.17; H, 7.95; N, 5.72. Found: C, 67.88; H, 7.98; N, 5.90%.

5.8.2. (2*S*,5*R*,6*S*)-6-Methyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-16. $[\alpha]_D^{20}=+112.4$ (*c* 0.76, $CHCl_3$); IR ($CHCl_3$): 1756, 1685; ^{1}H NMR: 7.40 (m, 10H), 6.10 (s, 1H, NH), 5.72 (s, 1H, C-(2)H), 5.16 (dd, 1H, $J=8.4$, 8.8), 4.67 (t, 1H, $J=8.8$), 4.20 (dd, 1H, $J=8.4$, 8.8), 4.10 (d, 1H, $J=5.9$, C-(5)H), 4.00 (m, 1H), 1.40 (d, 3H, $J=6.6$); ^{13}C NMR: 165.52 (C_4), 158.62, 137.66, 136.90, 129.60, 129.48, 128.95, 128.84, 128.12, 126.60, 81.23 (C_2), 70.41, 69.59 (C_6), 62.89 (C_5), 55.64, 15.48; MS *m*/*z*: 352 (M^+), 308, 203, 191, 176, 145, 104. Anal. calcd for $C_{20}H_{20}N_2O_4$: C, 68.17; H, 7.95; N, 5.72. Found: C, 68.10; H, 7.93; N, 5.53%.

5.8.3. (2*R*,5*R*,6*R*)-6-Methyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 17. $[\alpha]_D^{20}=+57.9$ (*c* 0.38, $CHCl_3$); IR ($CHCl_3$): 1757, 1683; ^{1}H NMR: 7.45 (m, 10H), 6.30 (s, 1H, NH), 5.94 (d, 1H, $J=1.9$, C-(2)H), 5.24 (dd, 1H, $J=8.7$, 10.0), 4.72 (t, 1H, $J=8.7$), 4.58 (dq, 1H, $J=6.2$, 9.9, C-(6)H), 4.25 (dd, 1H, $J=8.7$, 10.0), 3.18 (d, 1H, $J=9.9$, C-(5)H), 0.90 (d, 3H, $J=6.2$); ^{13}C NMR: 168.39 (C_4), 158.84, 137.82, 136.02, 129.68, 129.43, 129.20, 128.71, 128.67, 127.41, 83.11 (C_2), 70.50, 64.39 (C_6), 64.23 (C_5), 58.80, 18.60; MS *m*/*z*: 352 (M^+), 308, 202, 191, 176, 130, 104. Anal. calcd for $C_{20}H_{20}N_2O_4$: C, 68.17; H, 7.95; N, 5.72. Found: C, 68.22; H, 7.91; N, 5.89%.

5.8.4. (2*S*,5*R*,6*R*)-6-Methyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-17. $[\alpha]_D^{20}=+153.4$ (*c* 1.76, $CHCl_3$); IR ($CHCl_3$): 1755, 1684; ^{1}H NMR: 7.45 (s, 5H), 7.40 (s, 5H), 6.24 (s, 1H, NH), 5.92 (s, 1H, C-(2)H), 5.28 (dd, 1H, $J=8.8$, 10.0), 4.74 (m, 2H, C-(6)H), 4.30 (dd, 1H, $J=8.8$, 10.0), 3.20 (d, 1H, $J=10.0$, C-(5)H), 1.05 (d, 3H, $J=6.2$); ^{13}C NMR: 168.66 (C_4), 158.91, 137.42, 135.94, 130.00, 129.74, 129.22, 128.89, 128.70, 126.78, 85.48 (C_2), 72.39 (C_5), 70.47, 64.42 (C_6), 58.36, 18.89; MS *m*/*z*: 352 (M^+), 308, 202, 191, 176, 130, 104. Anal. calcd for $C_{20}H_{20}N_2O_4$: C, 68.17; H, 7.95; N, 5.72. Found: C, 67.94; H, 7.94; N, 5.60%.

5.9. Hydrolysis of perhydroxazin-4-ones 16 and *epi*-16: synthesis of (2*R*,3*R*)-2-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-3-hydroxybutanoic acid 18

From **16**: A solution of perhydroxazinone **16** (0.030 g, 0.085 mmol) in MeOH was cooled to 0°C and a previously prepared saturated solution of HCl in MeOH (3 mL) was added. The reaction was stirred overnight at 0°C. The solvent was removed in vacuo, a saturated solution of $NaHCO_3$ was added and the mixture was extracted with ethyl acetate. Column chromatography on silica gel (CH_2Cl_2/acetone 80/20) afforded the target compound in almost quantitative yield. $[\alpha]_D^{20}=+57.9$ (*c* 0.21, $CHCl_3$).

From *epi*-**16**: A solution of perhydroxazinone (0.020 g, 0.057 mmol) in dry MeOH was cooled at 0°C and a previously prepared saturated solution of HCl in MeOH (3 mL) was added. The reaction was stirred overnight at 0°C. The solvent was removed in vacuo, a saturated solution of $NaHCO_3$ was added and the mixture was extracted with ethyl acetate. Column chromatography on silica gel (CH_2Cl_2/acetone 80/20) afforded the target compound in almost quantitative yield. $[\alpha]_D^{20}=+54.4$ (*c* 0.11, $CHCl_3$); ^{1}H NMR: 7.39 (s, 5H), 6.55 (bs, 1H), 5.24 (dq, 1H, $J=7.4$, 8.8), 4.76 (t, 1H, $J=8.8$), 4.71 (d, 1H, $J=8.4$, C-(2)H), 4.37 (dq, 1H, $J=7.4$, 8.8), 4.24 (m, 1H, C-(3)H), 3.63 (d, 1H, $J=4.0$, OH), 1.19 (d, 3H, $J=6.8$); MS *m*/*z*: 265, 247, 229, 220, 203, 188, 176, 130, 104. Anal. calcd for $C_{24}H_{18}N_2O_4$: C, 72.35; H, 4.55; N, 7.03. Found: C, 72.23; H, 4.58; N, 7.18%.

5.10. General procedure for the synthesis of perhydroxazin-4-ones

Following the above procedure for the synthesis of perhydroxazin-4-ones, compounds **5**–**7** were prepared from the corresponding azadiene and aldehydes. The yields and diastereomeric ratios are reported in Table 3.

5.10.1. (2*R*,5*R*,6*S*)-6-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 20a. $[\alpha]_D^{20}=+149.0$ (*c* 0.31, $CHCl_3$); IR ($CHCl_3$): 1752, 1684; ^1H NMR: 7.40–7.08 (m, 10H), 6.70 (s, 1H, NH), 5.63 (s, 1H, C-(2)H), 5.12 (dd, 1H, $J=5.6$, 8.7), 4.58 (t, 1H, $J=8.7$), 4.43 (d, 1H, $J=3.9$, C-(5)H), 4.06 (dd, 1H, $J=5.6$, 8.7), 3.96 (m, 1H, C-(6)H), 1.55 (m, 4H), 0.95 (t, 3H, $J=6.8$); ^{13}C NMR: 165.93 (C_4), 159.09, 137.45, 136.71, 129.69, 128.84, 128.59, 128.55, 127.60, 126.58, 86.04 (C_2), 79.37 (C_6), 70.76, 60.55 (C_5), 55.00, 32.43, 18.97, 13.84; MS *m*/*z*: 380 (M^+), 308, 265, 176, 145. Anal. calcd for $C_{22}H_{24}N_2O_4$: C, 69.46; H, 6.36; N, 7.36. Found: C, 69.72; H, 6.39; N, 7.43%.

5.10.2. (2*R*,5*R*,6*R*)-6-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21a. $[\alpha]_D^{20}=+148.4$ (*c* 0.36, $CHCl_3$); IR ($CHCl_3$): 1755, 1683; ^1H NMR: 7.46 (s, 5H), 7.40 (s, 5H), 6.38 (s, 1H, NH), 5.87 (s, 1H, C-(2)H), 5.26 (dd, 1H, $J=8.8$, 10.0), 4.71 (t, 1H, $J=8.8$), 4.58 (m, 1H, C-(6)H), 4.30 (dd, 1H, $J=8.8$, 10.0), 3.28 (d, 1H, $J=10.1$, C-(5)H), 1.55 (m, 1H), 1.12 (m, 3H), 0.75 (t, 3H, $J=6.8$); ^{13}C NMR: 168.96 (C_4), 158.88, 137.63, 136.02, 129.81, 129.70, 129.17, 128.80, 128.73, 126.64, 85.40 (C_2), 75.54 (C_6), 70.35, 64.38 (C_5), 56.48, 34.14, 17.48, 13.74; MS *m*/*z*: 380 (M^+), 309, 265, 176, 145. Anal. calcd for $C_{22}H_{24}N_2O_4$: C, 69.46; H, 6.36; N, 7.36. Found: C, 69.18; H, 6.33; N, 7.21%.

5.10.3. (2*S*,5*R*,6*S*)-6-*i*-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-20b. Mp 240–242°C; $[\alpha]_D^{20}=+118.0$ (*c* 0.79, $CHCl_3$); IR ($CHCl_3$): 1751, 1685; ^1H NMR: 7.35 (m, 10H), 5.65 (s, 1H, NH), 5.48 (d, 1H, $J=1.7$, C-(2)H), 5.18 (dd, 1H, $J=5.4$, 9.0), 4.66 (t, 1H, $J=8.8$), 4.60 (d, 1H, $J=2.8$, C-(5)H), 4.23 (dd, 1H, $J=5.4$, 8.8), 3.24 (dd, 1H, $J=2.8$, 10.1, C-(6)H), 1.82 (m, 1H), 0.80 (t, 6H, $J=6.4$); ^{13}C NMR: 165.76 (C_4), 158.35, 138.03, 137.38, 137.38, 129.27, 129.08, 128.60, 128.47, 128.12, 126.76, 82.63 (C_2), 76.55 (C_6), 70.61, 60.30 (C_5), 53.45, 28.58, 19.37, 18.19; MS *m*/*z*: 380 (M^+), 337, 309, 265, 176, 146. Anal. calcd for $C_{22}H_{24}N_2O_4$: C, 69.46; H, 6.36; N, 7.36. Found: C, 69.70; H, 6.38; N, 7.52%.

5.10.4. (2*R*,5*R*,6*R*)-6-*i*-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 21b. $[\alpha]_D^{20}=+47.3$ (*c* 1.88, $CHCl_3$); IR ($CHCl_3$): 1755, 1679; ^1H NMR: 7.40 (m, 10H), 6.50 (s, 1H, NH), 5.95 (d, 1H, $J=1.9$, C-(2)H), 5.20 (dd, 1H, $J=8.8$, 10.1), 4.70 (t, 1H, $J=8.8$), 4.26 (m, 2H, C-(6)H), 3.42 (d, 1H, $J=10.3$, C-(5)H), 1.62 (m, 1H), 0.62 (d, 3H, $J=7.0$), 0.10 (d, $J=6.8$); ^{13}C NMR: 169.74 (C_4), 158.85, 137.79, 136.15, 129.66, 129.22, 129.14, 128.78; 128.45, 127.35, 82.90 (C_2), 70.78 (C_6), 70.20, 64.31 (C_5), 54.57, 27.11, 19.61, 13.00; MS *m*/*z*: 380 (M^+), 337, 309, 265, 176, 146. Anal. calcd for $C_{22}H_{24}N_2O_4$: C, 69.46; H, 6.36; N, 7.36. Found: C, 69.18; H, 6.32; N, 7.4%.

5.10.5. (2*S*,5*R*,6*R*)-6-*i*-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21b. $[\alpha]_D^{20}=+121.6$ (*c* 1.01, $CHCl_3$); IR ($CHCl_3$): 1753, 1697; ^1H NMR: 7.40 (m, 10H), 6.58 (s, 1H, NH), 5.85 (s, 1H, C-(2)H), 5.25 (dd, 1H, $J=8.7$, 10.1), 4.69 (t, 1H, $J=8.7$), 4.48 (dd, 1H, $J=1.6$, 10.5, C-(6)H), 4.32 (dd, 1H, $J=8.7$, 10.1), 3.40 (d, 1H, $J=10.5$, C-(5)H), 1.72 (dquint., 1H, $J=1.6$, 6.9), 0.93 (d, 3H, $J=7.0$), 0.15 (d, 3H, $J=6.8$); ^{13}C NMR: 169.36 (C_4), 158.70, 137.87, 135.98, 129.69, 129.55, 129.19, 128.81, 128.63, 126.52, 85.15 (C_2), 78.99 (C_6), 70.12, 64.39 (C_5), 53.86, 27.74, 19.88, 12.86; MS *m*/*z*: 380 (M^+), 337, 309, 265, 176, 146. Anal. calcd for $C_{22}H_{24}N_2O_4$: C, 69.46; H, 6.36; N, 7.36. Found: C, 69.70; H, 6.39; N, 7.21%.

5.10.6. (2*R*,5*R*,6*S*)-6-(Hept-1-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 20c. $[\alpha]_D^{20}=+133.8$ (*c* 0.27, $CHCl_3$); IR ($CHCl_3$): 1752, 1682; ^1H NMR: 7.38–7.20 (m, 10H), 6.43 (s, 1H, NH), 5.64 (s, 1H, C-(2)H), 5.13 (dd, 1H, $J=8.8$, 5.6), 4.59 (t, 1H, $J=8.8$), 4.45 (d, 1H, $J=4.0$, C-(5)H), 4.09 (dd, 1H, $J=8.8$, 5.6), 3.95 (m, 1H, C-(6)H), 1.70–1.00 (m, 12H), 0.86 (t, 3H, $J=7.3$); ^{13}C NMR: 165.92 (C_4), 159.06, 137.41, 135.60, 129.74, 128.88, 128.61, 128.57, 127.60, 126.60, 86.07 (C_2), 79.66 (C_6), 70.75, 60.57 (C_5), 54.95, 31.71, 30.44, 29.32, 29.07, 25.70, 22.58, 14.16; MS *m*/*z*: 436 (M^+), 308, 286, 242, 176, 145, 106, 91. Anal. calcd for $C_{26}H_{32}N_2O_4$: C, 71.53; H, 7.39; N, 6.42. Found: C, 71.44; H, 7.42; N, 6.28%.

5.10.7. (2*S*,5*R*,6*R*)-6-(Hept-1-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21c. $[\alpha]_D^{20}=+126.5$ (*c* 0.34, $CHCl_3$); IR ($CHCl_3$): 1754, 1682; ^1H NMR: 7.43 (s, 5H), 7.38 (s, 5H), 6.31 (s, 1H, NH), 5.88 (s, 1H, C-(2)H), 5.26 (dd, 1H, $J=9.0$, 10.0), 4.72 (t, 1H, $J=9.0$), 4.56 (m, 1H, C-(6)H), 4.31 (dd, 1H, $J=9.0$, 10.0), 3.28 (d, 1H, $J=10.0$, C-(5)H), 1.50–1.00 (m, 12H), 0.86 (t, 3H, $J=7.3$); ^{13}C NMR: 168.94 (C_4), 158.88, 137.54, 135.94, 129.81, 129.69, 129.14, 128.79, 128.72, 126.64, 85.37 (C_2), 75.72 (C_6), 70.34, 64.38 (C_5), 56.41, 32.09, 31.76, 29.34, 29.03, 24.20, 22.59, 14.06; MS *m*/*z*: 436 (M^+), 308, 286, 242, 176, 145, 106, 91. Anal. calcd for $C_{26}H_{32}N_2O_4$: C, 71.53; H, 7.39; N, 6.42. Found: C, 71.44, H, 7.42; N, 6.28%.

5.10.8. (2*R*,5*R*,6*R*)-6-Phenyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 21d. $[\alpha]_D^{20}=+63.4$ (*c* 0.76, $CHCl_3$); IR ($CHCl_3$): 1755, 1683; ^1H NMR: 7.60–7.00 (m, 13H), 6.74 (s, 1H, NH), 6.55 (d, 2H, $J=7.2$), 6.10 (d, 1H, $J=1.6$, C-(2)H), 5.56 (d, 1H, $J=10.2$, C-(6)H), 5.18 (dd, 1H, $J=8.4$, 10.8), 4.55 (t, 1H, $J=8.4$), 3.87 (dd, 1H, $J=8.4$, 10.8), 3.48 (d, 1H, $J=10.2$, C_5H); ^{13}C NMR: 168.97 (C_4), 159.43, 137.80, 137.78, 135.21, 129.74, 129.11, 129.00, 128.89, 128.74, 128.72, 127.87, 127.71, 127.37, 83.80 (C_2), 71.07, 69.81 (C_6), 64.73 (C_5), 59.10; MS *m*/*z*: 414 (M^+), 308, 264, 220, 146, 104. Anal. calcd for $C_{25}H_{22}N_2O_4$: C, 72.45; H, 5.35; N, 6.76. Found: C, 72.51; H, 5.38; N, 6.88%.

5.10.9. (2*S*,5*R*,6*R*)-6-Phenyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21d. $[\alpha]_D^{20}=+168.2$ (*c* 0.82, $CHCl_3$); IR ($CHCl_3$): 1754, 1685; ^{1}H NMR: 7.50–7.15 (m, 11H), 7.00 (t, 2H, *J*=8.00), 6.58 (d, 2H, *J*=6.8), 6.40 (s, 1H, NH), 6.10 (s, 1H, C-(2)H), 5.75 (d, 1H, *J*=9.6, C-(5)H), 5.25 (dd, 1H, *J*=8.5, 10.6), 4.57 (t, 1H, *J*=8.5), 3.92 (dd, 1H, *J*=8.5, 10.6), 3.53 (d, 1H, *J*=9.6, C-(6)H); ^{13}C NMR: 168.72 (C_4), 159.30, 137.48, 137.24, 134.78, 129.98, 128.82, 128.79, 128.68, 128.64, 128.56, 127.58, 127.08, 126.84, 85.87 (C_2), 77.72 (C_6), 70.89, 64.57 (C_5), 58.53; MS *m*/*z*: 414 (M^+), 308, 264, 220, 146, 104. Anal. calcd for $C_{25}H_{22}N_2O_4$: C, 72.45; H, 5.35; N, 6.76. Found: C, 72.18; H, 5.37; N, 6.67%.

5.10.10. (2*R*,5*R*,6*R*)-6-(4-Methoxyphenyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 21e. $[\alpha]_D^{20}=-1.4$ (*c* 1.61, $CHCl_3$); IR ($CHCl_3$): 1755, 1683; ^{1}H NMR: 7.60–6.60 (m, 15H), 6.20 (s, 1H, C-(2)H), 5.45 (d, 1H, *J*=10.0, C-(6)H), 5.14 (dd, 1H, *J*=8.6, 10.2), 4.52 (t, 1H, *J*=8.6), 3.85 (m, 4H), 3.47 (d, 1H, *J*=10.0, C-(5)H); ^{13}C NMR: 168.97 (C_4), 159.81, 159.00, 137.79, 135.26, 129.72, 129.25, 128.74, 128.65, 128.60, 128.31, 127.73, 127.37, 113.81, 83.37 (C_2), 70.70, 69.31 (C_6), 64.27 (C_5), 58.81, 55.29; MS *m*/*z*: 444 (M^+), 426, 382, 309, 281, 177, 146, 135, 104. Anal. calcd for $C_{26}H_{24}N_2O_5$: C, 70.26; H, 5.44; N, 6.30. Found: C, 70.18; H, 5.40; N, 6.19%.

5.10.11. (2*S*,5*R*,6*R*)-6-(4-Methoxyphenyl)-5-(2-oxo-4-phenyloxazolidin-3-yl)-2-phenyl-1,3-oxazinan-4-one *epi*-21e. $[\alpha]_D^{20}=+166.2$ (*c* 0.74, $CHCl_3$); IR ($CHCl_3$): 1753, 1685; ^{1}H NMR: 7.50–6.40 (m, 14H), 6.28 (s, 1H, NH), 6.08 (s, 1H, C-(2)H), 5.66 (d, 1H, *J*=10.0, C-(6)H), 5.22 (dd, 1H, *J*=8.5, 9.8), 4.59 (t, 1H, *J*=8.5), 3.95 (dd, 1H, *J*=8.5, 9.8), 3.84 (s, 3H), 3.52 (d, 1H, *J*=10.0, C-(5)H); ^{13}C NMR: 168.83 (C_4), 160.04, 159.28, 137.39, 135.12, 129.98, 129.78, 128.69, 128.37, 127.76, 126.85, 119.97, 85.86 (C_2), 77.53 (C_6), 70.88, 64.53 (C_5), 58.70, 55.39; MS *m*/*z*: 444 (M^+), 426, 382, 309, 281, 177, 146, 135, 104. Anal. calcd for $C_{26}H_{24}N_2O_5$: C, 70.26; H, 5.44; N, 6.30. Found: C, 70.53; H, 5.46; N, 6.45%.

5.10.12. (2*R*,5*R*,6*R*)-6-(4-Nitrophenyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 21f. $[\alpha]_D^{20}=-33.9$ (*c* 0.81, $CHCl_3$); IR ($CHCl_3$): 1756, 1687; ^{1}H NMR: 8.05 (d, 2H, *J*=8.80), 7.58 (m, 2H), 7.43 (m, 3H), 7.23 (m, 3H), 7.03 (s, 1H, NH), 6.96 (t, 2H, *J*=8.0), 6.20 (d, 2H, *J*=6.8), 6.15 (d, 1H, *J*=1.2, C-(2)H), 5.60 (d, 1H, *J*=10.0, C-(6)H), 5.10 (dd, 1H, *J*=8.8, 9.6), 4.60 (t, 1H, *J*=8.8), 4.00 (dd, 1H, *J*=8.8, 9.6), 3.42 (d, 1H, *J*=10.0, C-(5)H); ^{13}C NMR: 167.95 (C_4), 159.03, 147.94, 144.43, 137.04, 134.87, 129.74, 129.08, 128.89, 128.76, 127.98, 127.61, 127.34, 123.45, 83.69 (C_2), 70.54, 68.73 (C_6), 64.10 (C_5), 58.74; MS *m*/*z*: 460 (M^++1), 298, 265. Anal. calcd for $C_{25}H_{21}N_3O_6$: C, 65.35; H, 4.61; N, 9.15. Found: C, 65.19; H, 4.63; N, 9.01%.

5.10.13. (2*S*,5*R*,6*R*)-(6-(4-Nitrophenyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21f. $[\alpha]_D^{20}=+92.0$ (*c* 0.50, $CHCl_3$); IR ($CHCl_3$): 1756, 1686; ^{1}H NMR: 8.08 (d, 2H, *J*=8.0), 7.50–7.15 (m, 8H), 6.97 (t, 2H, *J*=8.0), 6.67 (d, 2H, *J*=8.0), 6.34 (s, 1H, NH), 6.10 (s, 1H, C-(2)H), 5.82 (d, 1H, *J*=10.4, C-(6)H), 5.16 (dd, 1H, *J*=8.8, 10.4), 4.65 (t, 1H, *J*=8.8), 4.06 (dd, 1H, *J*=8.8, 10.4), 3.48 (d, 1H, *J*=10.4, C-(5)H); ^{13}C NMR: 167.80 (C_4), 159.20, 148.10, 144.28, 136.64, 134.77, 130.38, 129.16, 129.00, 128.79, 127.99, 127.67, 126.83, 123.62, 86.12 (C_2), 76.81 (C_6), 70.67, 64.16 (C_5), 58.45; MS *m*/*z*: 460 (M^++1), 298, 265. Anal. calcd for $C_{25}H_{21}N_3O_6$: C, 65.35; H, 4.61; N, 9.15. Found: C, 65.63; H, 4.57; N, 9.36%.

5.10.14. (2*R*,5*R*,6*R*)-6-(2-Naphthyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 21g. $[\alpha]_D^{20}=-36.6$ (*c* 1.65, $CHCl_3$); IR ($CHCl_3$): 1754, 1683; ^{1}H NMR: 7.85 (m, 1H), 7.75–7.40 (m, 10H), 7.15 (m, 2H), 6.95 (m, 1H), 6.52 (m, 2H), 6.38 (m, 2H), 6.20 (s, 1H, C-(2)H), 5.70 (d, 1H, *J*=10.0, C-(6)H), 5.13 (dd, 1H, *J*=8.6, 10.1), 4.51 (t, 1H, *J*=8.6), 3.82 (dd, 1H, *J*=8.6, 10.1), 3.60 (d, 1H, *J*=10.0, C-(5)H); ^{13}C NMR: 168.77 (C_4), 159.20, 139.50, 137.69, 134.89, 133.51, 133.07, 129.44, 128.77, 128.51, 128.41, 128.24, 127.52, 127.48, 126.61, 126.33, 126.17, 124.42, 83.63 (C_2), 70.68, 69.89 (C_6), 64.35 (C_5), 58.96; MS *m*/*z*: 464 (M^+), 446, 402, 301, 196, 155, 104. Anal. calcd for $C_{29}H_{24}N_2O_4$: C, 74.98; H, 5.21; N, 6.03. Found: C, 75.25; H, 5.22; N, 5.85%.

5.10.15. (2*S*,5*R*,6*R*)-6-(2-Naphthyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21g. $[\alpha]_D^{20}=+81.3$ (*c* 1.07, $CHCl_3$); IR ($CHCl_3$): 1753, 1686; ^{1}H NMR: 7.85–7.25 (m, 13H), 6.90 (m, 1H), 6.45 (m, 4H), 6.16 (s, 1H, C-(2)H), 5.88 (d, 1H, *J*=10.2, C-(6)H), 5.17 (dd, 1H, *J*=8.6, 10.4), 4.54 (t, 1H, *J*=8.6), 3.88 (dd, 1H, *J*=8.6, 10.4), 3.60 (d, 1H, *J*=10.2, C-(5)H); ^{13}C NMR: 168.67 (C_4), 159.29, 137.35, 134.84, 134.73, 133.63, 133.12, 130.01, 128.84, 128.54, 128.39, 128.24, 127.60, 127.52, 126.90, 126.19, 126.42, 126.26, 85.97 (C_2), 78.01 (C_6), 70.79, 64.45 (C_5), 58.69; MS *m*/*z*: 464 (M^+), 446, 402, 301, 196, 155, 104. Anal. calcd for $C_{29}H_{24}N_2O_4$: C, 74.98; H, 5.21; N, 6.03. Found: C, 74.62; H, 5.18; N, 6.17%.

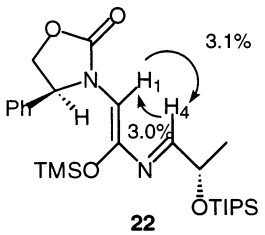
5.10.16. (2*R*,5*R*,6*R*)-6-(1-*t*-Butoxycarbonylindol-3-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one 21h. $[\alpha]_D^{20}=+20.9$ (*c* 2.49, $CHCl_3$); IR ($CHCl_3$): 1752, 1682; ^{1}H NMR: 8.12 (d, 1H, *J*=8.30), 7.62 (m, 2H), 7.42 (m, 3H), 7.28 (m, 3H), 7.15 (m, 3H), 6.80 (m, 2H), 6.54 (m, 2H), 6.15 (d, 1H, *J*=1.6, C-(2)H), 5.70 (d, 1H, *J*=10.0, C-(6)H), 5.05 (dd, 1H, *J*=8.7, 9.8), 4.54 (t, 1H, *J*=8.7), 3.90 (dd, 1H, *J*=8.7, 9.8), 3.74 (d, 1H, *J*=10.0, C-(5)H), 1.65 (s, 9H); ^{13}C NMR: 168.52 (C_4), 158.97, 149.28, 137.43, 135.30, 135.07, 129.48, 128.80, 128.74, 128.16, 127.62, 127.57, 124.60, 124.02, 122.86, 119.30, 117.66, 115.23, 83.83, 83.59 (C_2), 70.47, 64.15 (C_6), 63.95 (C_5), 58.40, 28.19; MS *m*/*z*: 553 (M^+), 479, 435, 390, 334, 309, 185, 146. Anal. calcd for $C_{32}H_{30}N_3O_6$: C, 69.55; H, 5.47; N, 7.60. Found: C, 69.81; H, 5.50; N, 7.76%.

5.10.17. (2*S*,5*R*,6*R*)-6-(1-*t*-Butoxycarbonylindol-3-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-phenyl-1,3-oxazinan-4-one *epi*-21h. $[\alpha]_D^{20}=+111.0$ (*c* 1.36, $CHCl_3$); IR ($CHCl_3$): 1749, 1684; ^{1}H NMR: 8.12 (d, 1H, *J*=8.20),

7.52–7.22 (m, 8H), 7.12 (m, 1H), 6.95 (m, 1H), 6.80 (m, 2H), 6.56 (m, 2H), 6.35 (s, 1H, NH), 6.12 (s, 1H, C-(2)H), 5.90 (d, 1H, $J=10.2$, C-(6)H), 5.10 (dd, 1H, $J=8.7$, 10.1), 4.58 (t, 1H, $J=8.7$), 4.00 (dd, 1H, $J=8.7$, 10.1), 3.78 (d, 1H, $J=10.2$, C-(5)H), 1.65 (s, 9H); ^{13}C NMR: 168.50 (C_4), 160.00, 149.30, 137.17, 135.41, 134.87, 130.03, 128.90, 128.85, 128.10, 127.60, 126.82, 124.23, 122.96, 119.24, 117.56, 115.33, 86.10 (C_2), 83.97, 72.10 (C_6), 70.55, 64.28 (C_5), 57.89, 28.22; MS m/z: 553 (M^+), 479, 435, 390, 334, 309, 185, 146. Anal. calcd for $C_{32}H_{30}N_3O_6$: C, 69.55; H, 5.47; N, 7.60. Found: C, 69.38; H, 5.44; N, 7.45%.

5.11. Preparation of (5*S*)-1-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-trimethylsilyloxy-3-aza-5-triisopropylsilyloxyhexa-1,3-diene 22

A solution of (*S*)-1-triisopropylsiloxyethyl-*N*-trimethylsilylimine **8** was prepared by dropwise addition of a solution of (*S*)-1-triisopropylsiloxyethyl aldehyde (0.23 g, 1.00 mmol) in heptane (5 mL) to a cooled (−10°C) THF solution of lithium bis(trimethylsilyl)amide (LiHMDSA) (1.10 mL, 1.10 mmol). The reaction mixture was stirred for 1 h at 0°C. Imine formation was confirmed by IR analysis of the reaction mixture ($\nu_{CN}=1685$ cm^{-1}). To the imine solution was added trimethylsilyl chloride (0.13 mL, 1.00 mmol) in one portion, and the mixture was allowed to stir for 1.5 h. The mixture was stirred for 15 min at 0°C and 1 h at rt. Triethylamine (0.30 mL, 2.00 mmol) was added in one portion and the mixture stirred for 5 min at 0°C. A solution of oxazolidinone-acetyl chloride **13** (1.2 equiv.) in toluene (prepared according Boger's method) was added very slowly (over 5 min) by syringe. Stirring was maintained for 30 min at 0°C and 1 h at rt. This yellow–orange mixture was then filtered through Celite. An aliquot of this mixture was evaporated and analysed by ^{1}H and ^{13}C NMR spectroscopy, showing that it was essentially pure **22**. $[\alpha]_D^{20}=+72.2$ (*c* 1.6, $CHCl_3$); IR ($CHCl_3$): 1748; ^{1}H NMR (200 MHz, $CDCl_3$): 7.52 (d, 1H, $J=4.6$, C-(4)H), 7.35 (m, 5H), 5.80 (s, 1H, C-(1)H), 5.32 (dd, 1H, $J=3.7$, 8.6), 4.65 (t, 1H, $J=8.6$), 4.30 (m, 2H, C_5H), 1.25 (d, 3H, $J=6.4$), 1.02 (m, 3H), 0.95 (s, 18H); ^{13}C NMR (50 MHz, $CDCl_3$): 163.4 (C_4), 156.5, 146.7, 139.1 (C_2), 128.9, 128.6, 126.3, 102.0 (C_1), 70.3, 70.1 (C_5), 59.4, 21.7, 17.8, 17.0, 12.1, 0.4.



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5.12. General procedure for the synthesis of perhydroxazin-4-ones

Following the procedure reported above for the synthesis of perhydroxazin-4-ones **5**–**7**, starting from the corresponding azadiene and aldehydes, the following compounds were prepared. The yields and diastereomeric ratio are reported in Table 5.

5.12.1. (2*R*,5*R*,6*S*)-6-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23a. $[\alpha]_D^{20}=+102.0$ (*c* 1.72, $CHCl_3$); IR ($CHCl_3$): 1755, 1683; ^{1}H NMR: 7.35 (s, 5H), 6.16 (s, 1H, NH), 5.10 (dd, 1H, $J=5.4$, 8.8), 4.71 (d, 1H, $J=3.6$, C-(2)H), 4.64 (t, 1H, $J=8.8$), 4.30 (d, 1H, $J=4.8$, C-(5)H), 4.12 (dd, 1H, $J=5.4$, 8.8), 4.03 (dq, 1H, $J=3.6$, 6.4, C-(1′)H), 3.78 (m, 1H, C-(6)H), 1.72–1.30 (m, 4H), 1.00 (m, 27H); ^{13}C NMR: 165.57 (C_4), 158.72, 137.38, 128.86, 128.45, 127.15, 86.50 (C_2), 79.33 (C_6), 70.90, 68.51 ($C_{1'}$), 60.87 (C_5), 55.51, 32.51, 19.10, 18.10, 18.06, 16.51, 14.00, 12.27; MS m/z: 504 (M^+), 461 (M^+–43), 389, 303, 230. Anal. calcd for $C_{27}H_{44}N_2O_5Si$: C, 64.25; H, 8.79; N, 5.55. Found: C, 64.42; H, 8.76; N, 5.41%.

5.12.2. (2*R*,5*R*,6*R*)-6-Propyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24a. $[\alpha]_D^{20}=+75.4$ (*c* 1.26, $CHCl_3$); IR ($CHCl_3$): 1755, 1683; ^{1}H NMR: 7.43 (s, 5H), 6.24 (bs, 1H, NH), 5.15 (dd, 1H, $J=8.8$, 9.6), 4.88 (dd, 1H, $J=1.2$, 4.0, C-(2)H), 4.72 (t, 1H, $J=8.8$), 4.65 (m, 1H, C-(6)H), 4.23 (dd, 1H, $J=8.8$, 9.6), 4.03 (dq, 1H, $J=4.0$, 6.8, C-(1′)H), 3.18 (d, 1H, $J=8.5$, C-(5)H), 1.22 (d, 3H, $J=6.8$), 1.04 (m, 4H), 0.84 (t, 3H, $J=6.3$); ^{13}C NMR: 167.80 (C_4), 158.37, 136.23, 129.38, 129.01, 128.20, 81.97 (C_2), 71.31 (C_6), 70.44, 69.59 ($C_{1'}$), 63.80 (C_5), 56.99, 34.33, 18.12, 18.09, 17.93, 16.97, 14.02, 12.35; MS m/z: 504 (M^+), 461 (M^+–43), 443, 389, 303, 230, 186. Anal. calcd for $C_{27}H_{44}N_2O_5Si$: C, 64.25; H, 8.79; N, 5.55. Found: C, 64.03; H, 8.82; N, 5.66%.

5.12.3. (2*R*,5*R*,6*S*)-6-(2-Methyl)-ethyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23b. $[\alpha]_D^{20}=+92.4$ (*c* 0.92, $CHCl_3$); IR ($CHCl_3$): 1754, 1684; ^{1}H NMR: 7.30 (m, 5H), 6.00 (s, 1H, NH), 5.05 (dd, 1H, $J=2.6$, 8.3), 4.70 (d, 1H, $J=3.8$, C-(5)H), 4.64 (d, 1H, $J=3.8$, C-(2)H), 4.57 (t, 1H, $J=8.3$), 4.04 (dd, 1H, $J=2.6$, 8.3), 3.94 (dq, 1H, $J=3.8$, 6.2, C-(1′)H), 3.34 (dd, 1H, $J=3.8$, 10.0, C-(6)H), 1.85 (m, 1H), 1.00 (m, 27H), 0.75 (d, 1H, $J=6.2$); ^{13}C NMR: 165.86 (C_4), 158.91, 138.02, 128.74, 128.55, 126.76, 87.25 (C_2), 85.64 (C_6), 71.28, 68.55 ($C_{1'}$), 59.87 (C_5), 54.11, 28.90, 19.30, 18.65, 17.98, 17.94, 16.42, 12.51; MS m/z: 504 (M^+), 461 (M^+–43), 389, 303, 230. Anal. calcd for $C_{27}H_{44}N_2O_5Si$: C, 64.25; H, 8.79; N, 5.55. Found: C, 64.41; H, 8.82; N, 5.47%.

5.12.4. (2*R*,5*R*,6*R*)-6-(2-Methyl)-ethyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24b. $[\alpha]_D^{20}=+63.7$ (*c* 1.82, $CHCl_3$); IR ($CHCl_3$): 1758, 1680; ^{1}H NMR: 7.40 (s, 5H), 6.28 (s, 1H, NH), 5.12 (dd, 1H, $J=8.8$, 9.6), 4.87 (d, 1H, $J=3.8$, C-(2)H), 4.70 (t, 1H, $J=8.8$), 4.54 (dd, 1H, $J=2.7$, 8.9, C-(6)H), 4.26 (dd, 1H, $J=8.8$, 9.6), 4.00 (dq, 1H, $J=3.8$, 6.3, C-(1′)H), 3.30 (d, 1H, $J=8.9$, C-(5)H), 1.80 (m, 1H), 1.18 (d, 3H, $J=6.3$), 1.02 (s, 21H), 0.90 (d, 3H, $J=6.8$), 0.28 (d, 3H, $J=6.7$); ^{13}C NMR: 168.43 (C_4), 158.66, 136.48, 129.53, 129.15, 128.57, 82.35 (C_2), 74.90 (C_6), 70.17, 69.79 ($C_{1'}$), 63.70

(C_5), 54.66, 28.15, 19.73, 17.96, 17.66, 16.74, 14.04, 12.23; MS m/z: 461 (M^+–43), 389, 303, 230. Anal. calcd for $C_{27}H_{44}N_2O_5Si$: C, 64.25; H, 8.79; N, 5.55. Found: C, 64.05; H, 8.76; N, 5.64%.

5.12.5. (2*R*,5*R*,6*S*)-6-(Hept-1-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23c. $[\alpha]_D^{20}=+94.3$ (c 0.81, $CHCl_3$); IR ($CHCl_3$): 1755, 1682; ^1H NMR: 7.35 (s, 5H), 6.15 (s, 1H, NH), 5.08 (dd, 1H, $J=5.1$, 8.5), 4.66 (d, 1H, $J=3.7$, C-(2)H), 4.60 (t, 1H, $J=8.5$), 4.25 (d, 1H, $J=4.4$, C-(5)H), 4.08 (dd, 1H, $J=5.1$, 8.5), 3.98 (dq, 1H, $J=3.7$, 6.3, C-(1′)H), 3.73 (m, 1H, C-(6)H), 1.65–1.20 (m, 12H), 1.00 (s, 24H), 0.88 (t, 3H, $J=7.3$); ^{13}C NMR: 165.94 (C_4), 158.74, 137.33, 128.74, 128.36, 127.13, 86.59 (C_2), 79.23 (C_6), 70.66, 68.45 ($C_{1'}$), 60.66 (C_5), 55.19, 31.52, 30.14, 29.09, 28.84, 25.40, 22.37, 17.53, 16.33, 13.84, 11.95; MS m/z: 561 (M^++1), 517 (M^+–43), 389, 359, 286. Anal. calcd for $C_{31}H_{52}N_2O_5Si$: C, 66.39; H, 9.35; N, 4.99. Found: C, 66.12; H, 9.30; N, 5.15%.

5.12.6. (2*R*,5*R*,6*R*)-6-(Hept-1-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24c. $[\alpha]_D^{20}=+84.2$ (c 0.43, $CHCl_3$); IR ($CHCl_3$): 1755, 1682; ^1H NMR: 7.40 (s, 5H), 6.31 (s, 1H, NH), 5.11 (dd, 1H, $J=8.9$, 9.6), 4.83 (d, 1H, $J=4.0$, C_2H), 4.69 (t, 1H, $J=8.8$), 4.60 (m, 1H, C-(6)H), 4.20 (dd, 1H, $J=8.8$, 9.6), 4.02 (dq, 1H, $J=4.01$, 6.4, C-(1′)H), 3.13 (d, 1H, $J=8.4$, C-(5)H), 1.75–1.15 (m, 12H), 0.95 (s, 24H), 0.88 (t, 3H, $J=7.3$); ^{13}C NMR: 168.10 (C_4), 160.44, 136.32, 128.80, 128.15, 127.63, 82.19 (C_2), 77.90 (C_6), 70.86, 68.05 ($C_{1'}$), 63.76 (C_5), 56.29, 31.82, 30.22, 29.19, 28.51, 24.11, 22.40, 16.83, 16.44, 12.34, 11.82; MS m/z: 561 (M^++1), 517 (M^+–43), 389, 359, 286.

5.12.7. (2*R*,5*R*,6*S*)-6-Phenyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23d. $[\alpha]_D^{20}=+183.2$ (c 1.19, $CHCl_3$); IR ($CHCl_3$): 1756, 1685; ^1H NMR: 7.48–6.95 (m, 10H), 6.35 (s, 1H, NH), 5.10 (d, 1H, $J=5.3$, C-(5)H), 4.92 (d, 1H, $J=3.7$, C-(2)H), 4.77 (dd, 1H, $J=5.87$, 8.37), 4.64 (bs, 1H), 4.15 (dq, 1H, $J=3.7$, 6.28, C-(1′)H), 3.85 (t, 1H, $J=8.3$), 3.72 (m, 1H, C-(6)H), 1.02 (s, 24H); ^{13}C NMR: 165.81 (C_4), 158.87, 137.13, 135.53, 128.65, 128.58, 128.50, 128.28, 127.25, 125.64, 86.02 (C_2), 80.34 (C_6), 70.71, 68.50 ($C_{1'}$), 60.75 (C_5), 55.80, 17.94, 17.90, 16.06, 12.14; MS m/z: 538 (M^+), 495, 432, 390, 338, 293, 267, 187. Anal. calcd for $C_{30}H_{42}N_2O_5Si$: C, 66.88; H, 7.86; N, 5.20. Found: C, 66.65; H, 7.88; N, 5.11%.

5.12.8. (2*R*,5*R*,6*R*)-6-Phenyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24d. Mp 69°C; $[\alpha]_D^{20}=+82.3$ (c 3.02, $CHCl_3$); IR ($CHCl_3$): 1757, 1687; ^1H NMR: 7.25 (m, 6H), 7.00 (m, 2H), 6.75 (s, 1H, NH), 6.50 (d, 2H, $J=8.3$), 5.82 (d, 1H, $J=9.6$, C_6H), 5.10 (dd, 1H, $J=8.5$, 10.2), 5.03 (d, 1H, $J=4.5$, C-(2)H), 4.55 (t, 1H, $J=8.5$), 4.18 (m, 1H, C-(1′)H), 3.8 (dd, 1H, $J=8.6$, 10.2), 3.32 (d, 1H, $J=9.6$, C_5H), 1.30 (d, 3H, $J=6.3$), 0.98 (s, 21H); ^{13}C NMR: 168.14 (C_4), 158.97, 137.90, 135.30, 128.84, 128.64, 128.47, 128.37, 127.52, 127.14, 84.25 (C_2), 72.15 (C_6), 70.71, 69.42 ($C_{1'}$), 64.08 (C_5), 58.74, 17.92, 17.60, 12.25; MS m/z: 538 (M^+), 495, 337, 292, 266, 188. Anal. calcd for $C_{30}H_{42}N_2O_5Si$: C, 66.88; H, 7.86; N, 5.20. Found: C, 67.17; H, 7.83; N, 5.29%.

5.12.9. (2*R*,5*R*,6*R*)-6-(4-Methoxyphenyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23e. $[\alpha]_D^{20}=+143.2$ (c 1.48, $CHCl_3$); IR ($CHCl_3$): 1754, 1684; ^1H NMR: 7.22 (m, 6H), 6.90 (m, 4H), 6.35 (s, 1H, NH), 5.03 (d, 1H, $J=5.1$, C-(6)H), 4.92 (d, 1H, $J=3.6$, C-(2)H), 4.78 (dd, 1H, $J=5.9$, 8.3), 4.55 (m, 1H), 4.14 (dq, 1H, $J=3.6$, 6.3, C-(1′)H), 3.85 (m, 4H C-(5)H), 3.75 (dd, 1H, $J=5.9$, 8.3), 1.00 (s, 24H); ^{13}C NMR: 166.40 (C_4), 159.58, 159.10, 137.15, 128.73, 128.05, 127.51, 127.29, 126.93, 113.96, 86.13 (C_2), 80.06 (C_6), 70.86, 68.51 ($C_{1'}$), 60.84 (C_5), 55.34, 17.98, 17.93, 16.11, 12.18; MS m/z: 525 (M^+–43), 432, 389, 322, 296, 204, 187. Anal. calcd for $C_{31}H_{44}N_2O_6Si$: C, 65.46; H, 7.80; N, 4.93. Found: C, 65.63; H, 7.83; N, 4.90%.

5.12.10. (2*R*,5*R*,6*R*)-6-(4-Methoxyphenyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24e. $[\alpha]_D^{20}=+55.8$ (c 2.24, $CHCl_3$); IR ($CHCl_3$): 1757, 1684; ^1H NMR: 7.32–6.98 (m, 5H), 6.80 (d, 2H, $J=8.7$), 6.58 (m, 3H), 5.75 (d, 1H, $J=9.6$, C-(6)H), 5.08 (dd, 1H, $J=8.6$, 10.2), 5.00 (d, 1H, $J=4.3$, C-(2)H), 4.56 (t, 1H, $J=8.6$), 4.14 (m, 1H, C-(1′)H), 3.83 (m, 4H), 3.30 (d, 1H, $J=9.6$, C_5H), 1.28 (d, 3H, $J=6.2$), 0.96 (s, 21H); ^{13}C NMR: 168.18 (C_4), 159.93, 158.87, 135.54, 130.05, 128.76, 128.33, 127.62, 113.79, 84.15 (C_2), 71.90 (C_6), 70.66, 69.48 ($C_{1'}$), 63.99 (C_5), 55.32, 17.91, 17.56, 12.25; MS m/z: 525 (M^+–43), 432, 389, 322, 296, 204, 187. Anal. calcd for $C_{31}H_{44}N_2O_6Si$: C, 65.46; H, 7.80; N, 4.93. Found: C, 65.28; H, 7.76; N, 4.84%.

5.12.11. (2*R*,5*R*,6*R*)-6-(1-*t*-Butoxycarbonylindol-3-yl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24f. $[\alpha]_D^{20}=+84.3$ (c 1.48, $CHCl_3$); IR ($CHCl_3$): 1753, 1733, 1684; ^1H NMR: 8.18 (d, 1H, $J=8.2$), 7.44 (d, 1H, $J=8.0$), 7.35–7.00 (m, 4H), 6.85 (m, 2H), 6.53 (m, 3H), 6.03 (d, 1H, $J=9.3$, C-(6)H), 5.02 (m, 2H, C-(2)H), 4.57 (t, 1H, $J=8.8$), 4.15 (dq, 1H, $J=4.5$, 6.2, C-(1′)H), 3.89 (dd, 1H, $J=8.8$, 10.0), 3.62 (d, 1H, $J=9.3$, C_5H), 1.65 (s, 9H), 1.32 (d, 3H, $J=6.2$), 0.97 (s, 21H); ^{13}C NMR: 167.77 (C_4), 158.87, 149.31, 135.42, 135.27, 128.84, 128.30, 127.56, 124.70, 124.25, 122.97, 119.49, 117.90, 115.22, 83.89, 83.77 (C_2), 70.51, 69.45 (C_6), 67.01 ($C_{1'}$), 63.88 (C_5), 58.10, 28.18, 17.94, 17.45, 12.22; MS m/z: 677 (M^+), 634, 591, 534, 471, 432, 389, 305, 187. Anal. calcd for $C_{37}H_{51}N_3O_7Si$: C, 64.93; H, 7.72; N, 6.31. Found: C, 65.15; H, 7.70; N, 6.43%.

5.12.12. (2*R*,5*R*,6*S*)-6-Cyclohexyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23g. $[\alpha]_D^{20}=+116.2$ (c 1.67, $CHCl_3$); IR ($CHCl_3$): 1754, 1684; ^1H NMR: 7.25 (s, 5H), 6.00 (s, 1H, NH), 5.08 (dd, 1H, $J=2.6$, 8.3), 4.58 (m, 3H, C-(2)H, C-(5)H), 4.06 (dd, 1H, $J=2.6$, 8.3), 3.94 (dq, 1H, $J=3.8$, 6.2, C-(1′)H), 3.45 (dd, 1H, $J=3.7$, 9.8, C-(6)H), 2.15–1.10 (m, 11H), 0.95 (s, 21H),

0.72 (d, 3H, $J=6.2$); ^{13}C NMR: 165.97 (C_4), 158.89, 137.88, 128.71, 128.52, 126.68, 86.99 (C_2), 84.01 (C_6), 71.36, 68.37 ($C_{1'}$), 59.81 (C_5), 53.78, 38.17, 29.14, 28.49, 26.24, 25.63, 25.49, 17.95, 17.91, 16.29, 12.12; MS m/z: 342 (M^+–202), 326, 292, 233. Anal. calcd for $C_{30}H_{48}N_2O_5Si$: C, 66.14; H, 8.88; N, 5.14. Found: C, 65.95; H, 8.92; N, 5.05%.

5.12.13. (2*R*,5*R*,6*R*)-6-Cyclohexyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24g. $[\alpha]_D^{20}=+66.5$ (c 1.08, $CHCl_3$); IR ($CHCl_3$): 1759, 1681; ^{1}H NMR: 7.40 (s, 5H), 6.28 (s, 1H, NH), 5.12 (dd, 1H, $J=8.7$, 9.6), 4.85 (d, 1H, $J=4.0$, C-(2)H), 4.70 (t, 1H, $J=8.7$), 4.54 (dd, 1H, $J=1.9$, 9.1, C-(6)H), 4.26 (dd, 1H, $J=8.7$, 9.6), 3.98 (dq, 1H, $J=4.0$, 3.3, C-(1′)H), 3.35 (d, 1H, $J=9.1$, C-(5)H), 1.70–1.10 (m, 12H), 1.00 (s, 21H), 0.85 (m, 2H); ^{13}C NMR: 168.65 (C_4), 158.80, 136.50, 129.49, 129.12, 128.51, 82.26 (C_2), 74.57 (C_6), 70.25, 69.75 ($C_{1'}$), 63.78 (C_5), 53.91, 37.80, 30.13, 26.45, 26.16, 25.99, 24.43, 17.95, 16.73, 12.17; MS m/z: 501 (M^+–43), 342, 325, 292, 233. Anal. calcd for $C_{30}H_{48}N_2O_5Si$: C, 66.14; H, 8.88; N, 5.14. Found: C, 66.40; H, 8.85; N, 5.03%.

5.12.14. (2*R*,5*R*,6*S*)-6-Ethyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23h. $[\alpha]_D^{20}=+100.0$ (c 1.04, $CHCl_3$); IR ($CHCl_3$): 1756, 1684; ^{1}H NMR: 7.32 (s, 5H), 6.10 (s, 1H, NH), 5.10 (dd, 1H, $J=5.2$, 8.5), 4.70 (d, 1H, $J=3.7$, C-(2)H), 4.61 (t, 1H, $J=8.5$), 4.30 (d, 1H, $J=4.4$, C-(5)H), 4.08 (dd, 1H, $J=5.2$, 8.5), 4.02 (dq, 1H, $J=3.7$, 6.3, C-(1′)H), 3.67 (m, 1H, C-(6)H), 1.60 (m, 2H), 1.00 (m, 27H); ^{13}C NMR: 165.89 (C_4), 158.89, 137.66, 129.01, 128.67, 128.38, 86.69 (C_2), 81.22 (C_6), 70.86, 68.66 ($C_{1'}$), 61.10 (C_5), 55.38, 23.76, 17.99, 16.42, 12.24, 10.26; MS m/z: 447 (M^+–43), 389, 289, 216. Anal. calcd for $C_{26}H_{42}N_2O_5Si$: C, 63.64; H, 8.63; N, 5.71. Found: C, 63.80; H, 8.67; N, 5.60%.

5.12.15. (2*R*,5*R*,6*R*)-6-Ethyl-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24h. $[\alpha]_D^{20}=+80.5$ (c 0.88, $CHCl_3$); IR ($CHCl_3$): 1759, 1684; ^{1}H NMR: 7.40 (s, 5H), 6.25 (s, 1H, NH), 5.15 (dd, 1H, $J=8.7$, 9.8), 4.86 (dd, 1H, $J=1.2$, 4.0, C-(2)H), 4.70 (t, 1H, $J=8.7$), 4.60 (dt, 1H, $J=3.3$, 8.5, C-(6)H), 4.20 (dd, 1H, $J=8.7$, 9.8), 4.02 (dq, 1H, $J=4.0$, 6.2, C-(1′)H), 3.15 (d, 1H, $J=8.5$, C-(5)H), 1.60 (m, 2H), 1.20 (d, 3H, $J=6.2$), 1.00 (s, 21H), 0.76 (t, 3H, $J=7.3$); ^{13}C NMR: 168.09 (C_4), 158.61, 136.55, 129.54, 129.22, 128.36, 82.19 (C_2), 72.57 (C_6), 70.43, 69.73 ($C_{1'}$), 63.84 (C_5), 56.79, 25.13, 17.99, 16.93, 12.33, 8.91; MS m/z: 447 (M^+–43), 389, 289, 216. Anal. calcd for $C_{26}H_{42}N_2O_5Si$: C, 63.64; H, 8.63; N, 5.71. Found: C, 63.43; H, 8.60; N, 5.83%.

5.12.16. (2*R*,5*R*,6*S*)-6-(3-Pyridyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23i. $[\alpha]_D^{20}=+63.9$ (c 1.38, $CHCl_3$); IR ($CHCl_3$): 1730, 1683; ^{1}H NMR: 8.55 (bs, 1H), 8.35 (bs, 1H), 7.58 (d, 1H, $J=7.5$), 7.35–7.15 (m, 4H), 6.85 (d, 2H, $J=6.8$), 6.00 (bs, 1H, NH), 5.26 (m, 1H, C-(6)H), 5.10 (m, 2H, C-(2)H), 4.55 (t, 1H, $J=8.9$), 4.08 (m, 2H, C-(1′)H), 3.92 (d, 1H, $J=4.2$, C-(5)H), 1.25 (d, 3H, $J=6.2$), 1.05 (s, 21H); ^{13}C NMR: 168.84 (C_4), 160.64, 135.73, 133.61, 129.49, 127.69, 77.42 (C_2), 71.42 (C_6), 70.86, 69.81 ($C_{1'}$), 62.25 (C_5), 61.51, 18.55, 18.07, 18.01, 12.43; MS m/z: 496 (M^+–43), 389, 267, 187. Anal. calcd for $C_{29}H_{41}N_3O_5Si$: C, 64.53; H, 7.66; N, 7.79. Found: C, 64.70; H, 7.70; N, 7.76%.

5.12.17. (2*R*,5*R*,6*R*)-6-(3-Pyridyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24i. $[\alpha]_D^{20}=+77.0$ (c 0.80, $CHCl_3$); IR ($CHCl_3$): 1758, 1689; ^{1}H NMR: 8.60 (bs, 1H), 8.48 (bs, 1H), 7.45 (m, 1H), 7.20 (m, 2H), 7.05 (m, 2H), 6.58 (d, 2H, $J=7.0$), 6.43 (s, 1H, NH), 5.87 (d, 1H, $J=9.8$, C-(6)H), 5.05 (m, 2H, C-(2)H), 4.60 (t, 1H, $J=8.7$), 4.16 (dq, 1H, $J=4.7$, 6.2, C-(1′)H), 3.95 (dd, 1H, $J=$ 8.7, 10.3), 3.28 (d, 1H, $J=9.8$, C_5H), 1.30 d, 3H, $J=6.2$), 1.00 (s, 21H); ^{13}C NMR: 167.60 (C_4), 158.99, 134.95, 134.86, 129.05, 128.95, 127.55, 84.47 (C_2), 70.65 (C_6), 70.21, 69.24 ($C_{1'}$), 63.97 (C_5), 58.53, 17.92, 17.73, 12.22; MS m/z: 496 (M^+–43), 389, 267, 187. Anal. calcd for $C_{29}H_{41}N_3O_5Si$: C, 64.53; H, 7.66; N, 7.79. Found: C, 64.31; H, 7.63; N, 7.92%.

5.12.18. (2*R*,5*R*,6*S*)-6-(2-Thienyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23j. $[\alpha]_D^{20}=+124.4$ (c 1.16, $CHCl_3$); IR ($CHCl_3$): 1754, 1686; ^{1}H NMR: 7.40 (d, 1H, $J=4.80$), 7.29 (m, 3H), 7.10 (m, 3H), 7.00 (m, 1H), 6.32 (s, 1H, NH), 5.33 (d, 1H, $J=5.2$, C-(6)H), 4.95 (d, 1H, $J=3.8$, C-(2)H), 4.89 (dd, 1H, $J=5.6$, 8.4), 4.71 (d, 1H, $J=5.2$, C-(5)H), 4.14 (dq, 1H, $J=3.8$, 6.4, C-(1′)H), 4.08 (t, 1H, $J=8.4$), 3.86 (dd, 1H, $J=5.6$, 8.4), 1.04 (s, 21H), 0.98 (d, 3H, $J=6.4$); ^{13}C NMR: 165.04 (C_4), 158.89, 137.37, 137.17, 128.59, 128.48, 127.18, 126.98, 125.38, 124.89, 86.20 (C_2), 78.05 (C_6), 71.09, 68.30 ($C_{1'}$), 60.54 (C_5), 55.91, 18.12, 18.07, 16.16, 12.27; MS m/z: 544 (M+), 501 (M^+–43), 432, 389, 298, 272, 187. Anal. calcd for $C_{28}H_{40}N_2O_5SSi$: C, 61.73; H, 7.40; N, 5.14. Found: C, 61.94; H, 7.36; N, 5.03%.

5.12.19. (2*R*,5*R*,6*R*)-6-(2-Thienyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24j. $[\alpha]_D^{20}=+103.7$ (c 0.98, $CHCl_3$); IR ($CHCl_3$): 1758, 1688; ^{1}H NMR: 7.28 (m, 2H), 7.17 (m, 2H), 7.02 (m, 2H), 6.77 (m, 2H), 6.42 (s, 1H, NH), 6.14 (d, 1H, $J=9.2$, C-(6)H), 5.13 (dd, 1H, $J=8.6$, 10.0), 5.07 (dd, 1H, $J=1.6$, 4.40 C-(2)H), 4.65 (t, 1H, $J=8.6$), 4.15 (dq, 1H, $J=4.4$, 6.4, C-(1′)H), 3.98 (dd, 1H, $J=8.6$, 10.0), 3.46 (d, 1H, $J=9.2$, C-(5)H), 1.30 (d, 3H, $J=6.4$), 1.04 (s, 21H); ^{13}C NMR: 167.06 (C_4), 158.68, 140.98, 135.45, 128.83, 128.74, 127.43, 126.50, 126.36, 125.78, 82.90 (C_2), 70.83, 69.78 (C_6), 69.24 ($C_{1'}$), 63.91 (C_5), 59.43, 18.12, 18.09, 17.14, 12.36; MS m/z: 501 (M^+–43), 432, 389, 298, 272, 187. Anal. calcd for $C_{28}H_{40}N_2O_5SSi$: C, 61.73; H, 7.40; N, 5.14. Found: C, 61.50; H, 7.37; N, 5.27%.

5.12.20. (2*R*,5*R*,6*S*)-6-(2-Furyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 23k. $[\alpha]_D^{20}=+94.8$ (c 0.48, $CHCl_3$); IR ($CHCl_3$): 1757, 1688; ^{1}H NMR: 7.51 (m, 1H), 7.32 (m, 3H), 7.16 (m, 2H), 6.50 (m, 2H), 6.28 (s, 1H, NH), 5.10 (m, 2H, C-(6)H), 4.90 (d, 1H, $J=3.6$, C-(2)H), 4.65 (d,

1H, $J=4.4$, C-(5)H), 4.35 (t, 1H, $J=8.8$), 4.13 (dq, 1H, $J=3.6$, 6.4 C-(1′)H), 3.93 (dd, 1H, $J=5.2$, 8.4), 1.04 (m, 24H); ^{13}C NMR: 164.84 (C_4), 158.70, 148.30, 142.76, 137.52, 128.66, 128.45, 126.96, 110.68, 108.92, 86.35 (C_2), 75.81 (C_6), 71.18, 68.38 ($C_{1'}$), 60.53 (C_5), 55.20, 18.12, 18.07, 16.28, 12.30; MS m/z: 485 (M^+–43), 389, 256, 187. Anal. calcd for $C_{28}H_{40}N_2O_6Si$: C, 63.61; H, 7.63; N, 5.30. Found: C, 63.49; H, 7.67; N, 5.45%.

5.12.21. (2*R*,5*R*,6*R*)-6-(2-Furyl)-5-[(4*S*)-2-oxo-4-phenyloxazolidin-3-yl]-2-[1(*S*)-triisopropylsilanyloxyethyl]-1,3-oxazinan-4-one 24k. $[\alpha]_D^{20}=+151.3$ (c 0.96, $CHCl_3$); IR ($CHCl_3$): 1760, 1692; ^{1}H NMR: 7.30 (m, 4H), 6.94 (m, 2H), 6.48 (bs, 1H, NH), 6.37 (m, 2H), 5.85 (d, 1H, $J=9.2$, C-(6)H), 5.14 (dd, 1H, $J=8.6$, 10.2), 5.07 (dd, 1H, $J=2.0$, 4.4, C-(2)H), 4.65 (t, 1H, $J=8.6$), 4.10 (dq, 1H, $J=4.4$, 6.4, C-(1′)H), 3.98 (dd, 1H, $J=8.6$, 10.2), 3.88 (d, 1H, $J=9.2$, C-(5)H), 1.25 (d, 3H, $J=6.4$), 1.02 (s, 21H); ^{13}C NMR: 167.03 (C_4), 158.62, 150.03, 142.91, 135.69, 128.94, 128.80, 127.39, 110.57, 82.06 (C_2), 70.72, 68.61 (C_6), 67.44 ($C_{1'}$), 63.79 (C_5), 55.27, 18.08, 18.04, 16.80, 12.35; MS m/z: 485 (M^+–43), 389, 256, 187. Anal. calcd for $C_{28}H_{40}N_2O_6Si$: C, 63.61; H, 7.63; N, 5.30. Found: C, 63.82; H, 7.60; N, 5.22%.

Acknowledgements

This work was partially supported by 'Progetto Strategico sulle applicazioni delle Microonde, CNR, Rome'. Thanks are due to MURST, Cofin'98 (Rome) for financial support and to Dr. Giovanni Piersanti for helpful discussions. E.C. thanks Farchemia s.r.l. Treviglio (BG), Italy, for financial support.

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