PERKIN 1

Cross-coupling reactions in *Cinchona* alkaloid chemistry: aryl-substituted and dimeric quinine, quinidine, as well as quincorine and quincoridine derivatives

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Cross-coupling reactions of modified *Cinchona* alkaloids provide access to a wide variety of novel arylated and dimeric derivatives of quinine and quinidine containing a single and double 1,2-amino alcohol functionality. Sonogashira and Heck reactions allow functionalization of ethynyl and 11-iodovinyl precursors. The role of bystander functionality is investigated.

Introduction

In recent years, the study of transition-metal mediated reactions has facilitated progress in organic synthesis and *vice versa*.[1] Metal-catalyzed cross-coupling reactions have been extensively employed, spanning the range of complex natural products to supramolecular chemistry and materials science. Among the many transition metals used, palladium[2,3] complexes are probably most valuable. At the outset of our work it was not clear whether the basic bridgehead amine and other functionality of the alkaloids including the C9-hydroxy and its protection groups would help or hinder the planned carbon–carbon coupling reactions.

The quest for novel ligands of neuronal receptors has been a further incentive, as the quinuclidine nucleus has been found to be a good mimic for the quaternary nitrogen in acetylcholine. Unlike acetylcholine, the quaternary nitrogen of which is necessarily charged, the unprotonated form of quinuclidines is able to cross the blood–brain barrier.[4] Quinuclidine derivatives with aromatic substituents in the 3-position are able to block M_1 (**1** and **2**), 5-HT_3 (**3**) and NK_1-receptors[5,6] and to act as squalene synthase inhibitors (**4**) (Fig. 1).[7] In contrast to *de novo* syntheses which provide the desired target molecules only in poor yields and as racemic mixtures, cross-coupling reactions of quinuclidine derivatives offer an efficient access to the desired lead structures.[8]

Dimeric alkaloids, *e.g.* vincristine and vinblastine, have been used as potent antitumor agents.[9] Dimeric *Cinchona* alkaloids are decisive as ligands in the AD reaction. Thus, dimeric quinine- and quinidine-based phthalazine- and pyrimidine-bridged ligands have outperformed monomeric ligands in most reactions.[10] Chloroquine is still one of the main antimalarial drugs, but its efficacy is being steadily eroded by the spread of resistant parasites. The development of alternative agents remains a major goal. Dimeric quinoline-based antimalaria agents such as piperaquine-like quinine derivative **5** (Fig. 2) are of current interest[11] since some of these compounds exhibit high activity against chloroquine-resistant parasites.[12] Further examples of dimeric *Cinchona* alkaloid derivatives are

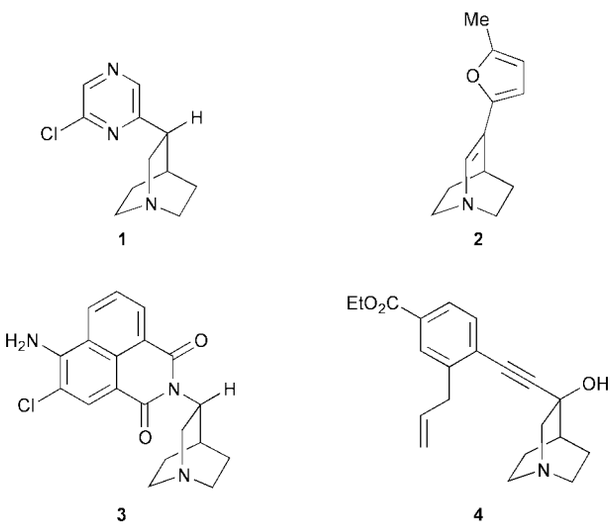

Fig. 1 Quinuclidine lead structures.

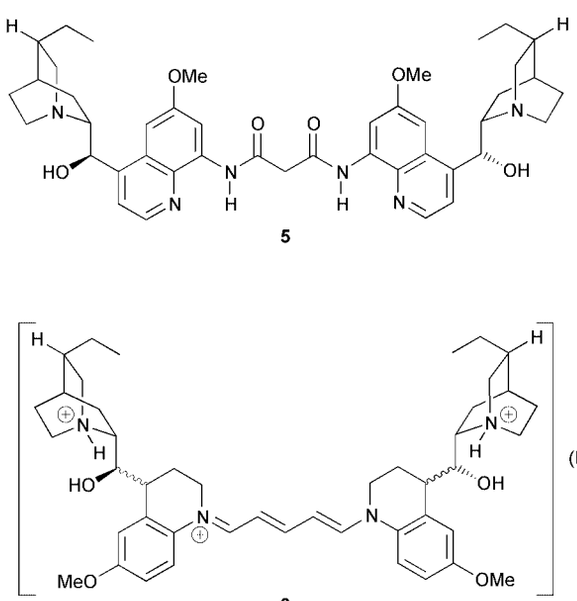

Fig. 2 Dimerized *Cinchona* alkaloids.

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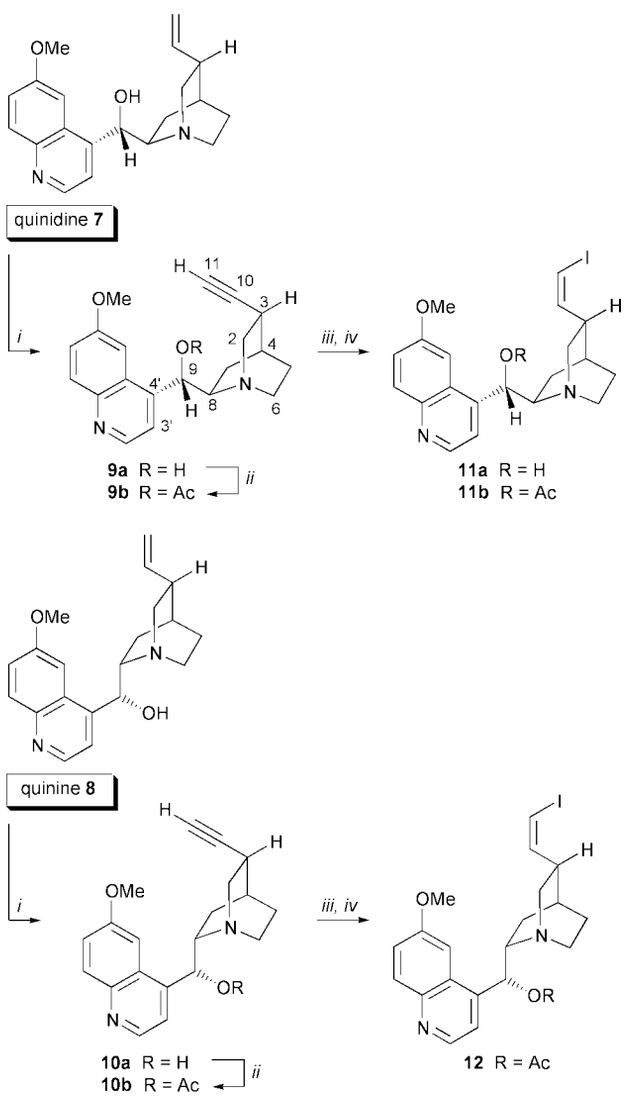
chiral symmetrical pentamethinium cyanine dyes with hexahydroquininyl and -quinidinyl end groups (**6**).[13]

In the course of our work we have prepared a wide variety of arylated and dimeric derivatives from acetylenic and vinylic precursors. The acetylenic derivatives of the diyne and enediyne type described herein represent an entirely new class of *Cinchona* alkaloids.

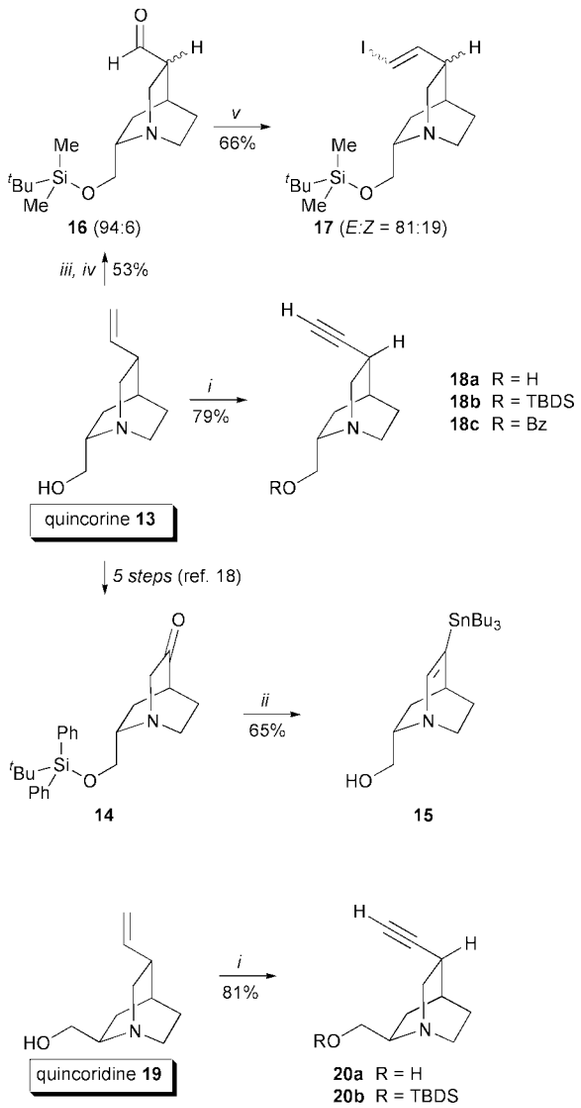
Results and discussion

A useful route to arylalkynes and conjugated enynes is the Pd-catalyzed coupling of terminal alkynes with aryl or alkenyl halides as described by Sonogashira *et al.*[14] Numerous applications have been reported, especially in the construction of complex unsaturated frameworks of enediyne antibiotics with (*Z*)-1,2-dichloroethylene.[15] To explore the application of this cross-coupling reaction to *Cinchona* alkaloids we have used 10,11-didehydro-derivatives **9**, **10**, **18**, **20** of quinine **8**, quinidine **7**, Quincorine® (QCI) **13** and Quincoridine® (QCD) **19**, vinyl iodides **11**, **12**, **17** and vinylstannane **15** as precursors (Schemes 1 and 2). The series of terminal alkynes **9**, **10**, **18**, **20** was prepared efficiently in two steps from the naturally occurring *Cinchona* alkaloids and from QCI (**13**) and QCD



(atom numbering for *Cinchona* alkaloids according to Rabe)

Scheme 1 Synthesis of precursors for quinine and quinidine cross-coupling. *Reagents and conditions*: *i*, 1. Br_2, $CHCl_3$–CCl_4, 0 °C, 2 h, 2. Et_3N, $CHCl_3$, rt, 2 h, 3. KOH, aliquat 336®, THF, 6–20 h, rt or 70 °C; *ii*, AcCl, Et_3N, DCM, 0 °C→rt, 16 h; *iii*, I_2, morpholine, toluene, 55 °C, 10 h, 91–97%; *iv*, $TsNHNH_2$, NaOAc, THF, H_2O, 55 °C, 4–6 h, 56–65%.



Scheme 2 Synthesis of precursors for quincorine and quincoridine cross-coupling. *Reagents and conditions*: *i*, 1. Br_2, $CHCl_3$–CCl_4, 0 °C, 2 h, 2. Et_3N, $CHCl_3$, rt, 2 h, 3. KOH, aliquat 336®, THF, 6–20 h, rt or 70 °C; *ii*, 1. 2,4,6-triisopropylbenzenesulfonyl hydrazide, Et_2O, rt, 16 h, 2. *n*-BuLi, TMEDA, hexane, −78 °C→0 °C, 1 h; 3. Bu_3SnCl, 0 °C→rt, 2 h; *iii*, 1. TBDSCl, Et_3N, DMAP, DCM, rt, 14 h, 2. $K_3[Fe(CN)_6]$, K_2CO_3, OsO_4, ^tBuOH–H_2O (1 : 1), rt, 8 h; *iv*, $NaIO_4$, SiO_2, H_2O, DCM, rt, 15 min; *v*, $CrCl_2$, CHI_3, THF, 0 °C→rt, 3 h.

(**19**).[16] Iodinated alkynes were easily transformed into corresponding (*Z*)-vinyl iodides **11**, **12**, **17** by *p*-tolylsulfonyl hydrazide-mediated hydrogenation. (*E*)-Vinyl iodide **17** was obtained upon treatment of C10-aldehyde **16** with $CrCl_2$ and CHI_3.[17] Vinylstannane **15** was prepared from ketone **14** *via* hydrazide reduction.[18]

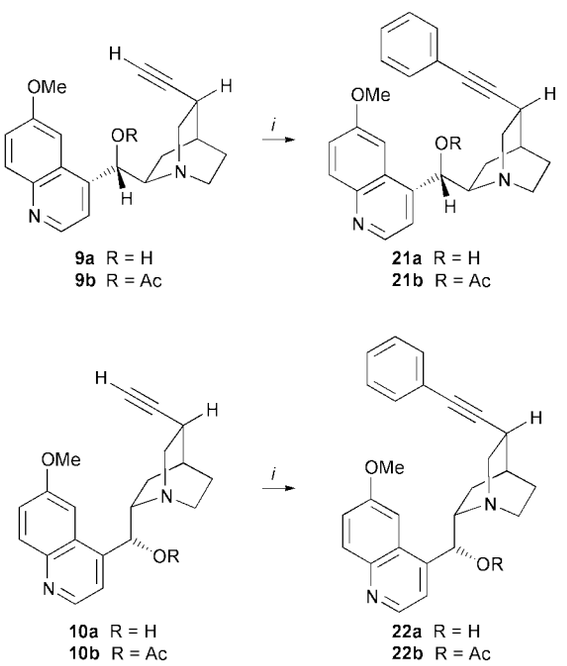
Usually, the Sonogashira coupling is carried out in the presence of catalytic amounts of a Pd(II)-complex and CuI in an amine as solvent. The use of cosolvents like THF or DMF has also been reported.[19]

In view of differences in reactivity of halides and alkynes we have optimized the $(Ph_3P)_2PdCl_2$-mediated coupling of unprotected 10,11-didehydroquinidine **9a** with iodo- and bromobenzene with respect to amine, solvent, temperature and reaction time. In accord with other optimization studies[20] reaction of the coupling precursors with $(Ph_3P)_2PdCl_2$ (0.05 eq.) and CuI (0.1 eq.) in a mixture (1 : 1) of Et_3N and THF proved to be suitable (Scheme 3, Table 1). Due to strong basicity of the bridgehead nitrogen and the presence of a quinoline nitrogen, Sonogashira coupling of **9a** is also feasible without addition of an external amine furnishing the desired internal alkyne in moderate yield (44%).

Table 1 Optimization of Sonogashira coupling of 10,11-didehydroquinidine and -quinine with phenyl halides

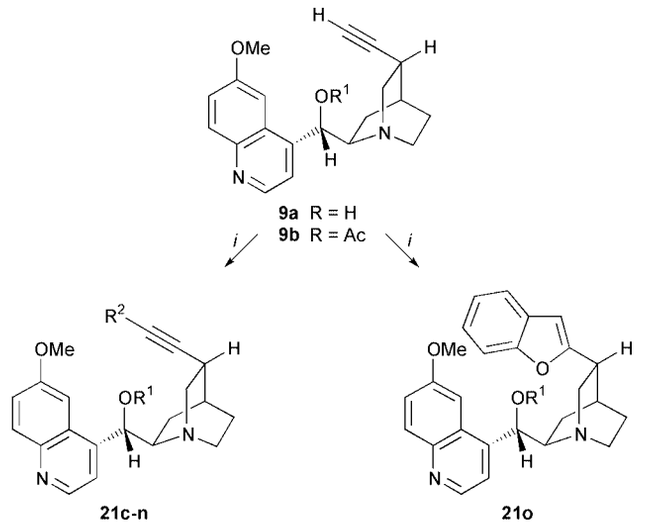
Entry	Alkyne	Ph-X (eq.)	Solvent, base[a]	Time/h	Yield (%)
1	**21a**	Ph-I (1.0)	THF, Et_2NH	6	60
2	**21a**	Ph-I (1.5)	THF, $^iPr_2NH$	6	66
3	**21a**	Ph-I (1.5)	—, Et_3N	16[b]	51
4	**21a**	Ph-I (1.5)	THF, Et_3N	6	73
5	**21a**	Ph-I (1.5)	THF, Et_3N	14	80
6	**21a**	Ph-I (1.5)	Et_2O, Et_3N	14	68
7	**21a**	Ph-I (1.5)	Dioxan, Et_3N	14	63
8	**21a**	Ph-I (1.5)	DMF, Et_3N	14	65
9	**21a**	Ph-I (1.5)	THF, —	72	44
10	**21a**	Ph-Br (1.5)	THF, Et_3N	6	53
11	**21a**	Ph-Br (1.5)	THF, Et_3N	20	71
12	**21b**	Ph-I (1.5)	THF, Et_3N	14	94
13	**22a**	Ph-I (1.5)	THF, Et_3N	16	70
14	**22b**	Ph-I (1.5)	THF, Et_3N	16	86

[a] Typically, reactions were carried out at rt. [b] Temperature: 60 °C.



Scheme 3 Optimized Sonogashira coupling of 10,11-didehydroquinidine **9a**,**b** and -quinine **10a**,**b**. *Reagents and conditions*: *i*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), phenyl halide (1.0–1.5 eq.), THF, amine.

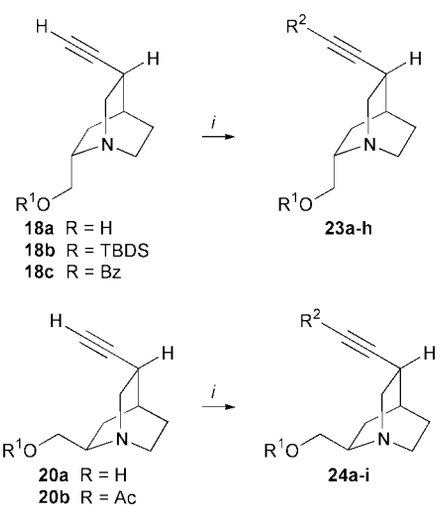
Although an unprotected 1,2-amino alcohol unit was present in terminal alkyne **9a** the desired coupling product **21a** was obtained in 80% yield using iodobenzene and in 71% yield using bromobenzene (Table 1, entries 5 and 11). Likewise, coupling of 10,11-didehydroquinine **10a** with iodobenzene furnished internal alkyne **22a** in 70% yield. Protection of the C9-hydroxy group by acetylation as in *Cinchona* alkaloid precursors **9b** and **10b** gave higher yields of up to 94% (Schemes 1 and 4, Tables 1 and 2). Reaction with less reactive bromobenzene required longer reaction times, but was also feasible under mild conditions (Table 1, entries 10, 11). Formation of symmetrical diyne side products by oxidative homocoupling was not observed in the optimized Sonogashira couplings of 10,11-didehydro-derivatives of quinine, quinidine, QCI and QCD. Moreover, ordinary, nondegassed reagent-grade solvents could be used without decrease in yield. Optimized Sonogashira coupling of 10,11-didehydroquinidine **9a**,**b** with various substituted aryl and vinyl halides furnished the desired internal alkynes **21c**–**n** with yields from 67 to 94%. When 2-iodophenol was used as halide benzofuran **21o** was obtained



Scheme 4 Sonogashira coupling of 10,11-didehydroquinidine **9a**,**b** with substituted aryl and vinyl halides. *Reagents and conditions*: *i*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), aryl or vinyl halide (1.0–1.5 eq.), THF, Et_3N, 16 h.

exclusively by a tandem reaction involving cross-coupling and intramolecular cyclization. The corresponding coupling of 10,11-didehydroquinidine **9b** with 2-iodoaniline furnished the substituted alkyne **21n**.[21] Indoles can only be obtained under forcing conditions.[22]

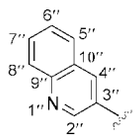
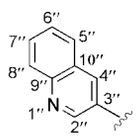
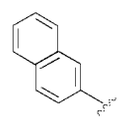
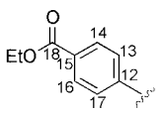
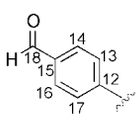
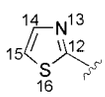
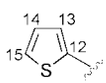
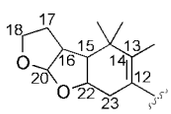
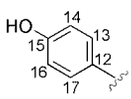
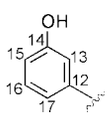
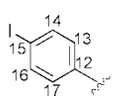
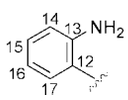
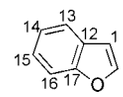
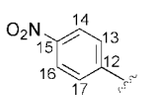
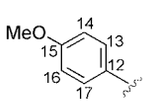
Pd-mediated cross-coupling was also applied to polar 1,2-amino alcohols didehydro-QCI and didehydro-QCD (Scheme 5). Unprotected alkynes **18a** and **20a** coupled under



Scheme 5 Sonogashira coupling of 10,11-didehydroquincorine **18a**,**c** and 10,11-didehydroquincoridine **20a**,**b** with substituted aryl and vinyl halides. *Reagents and conditions*: *i*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), aryl or vinyl halide (1.0–1.5 eq.), THF, Et_3N, 16 h.

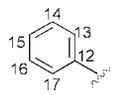
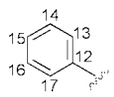
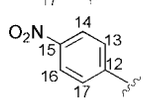
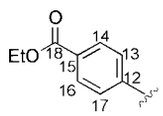
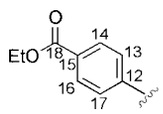
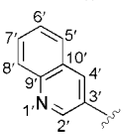
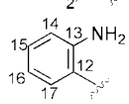
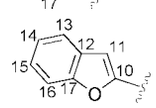
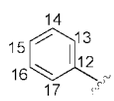
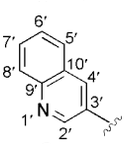
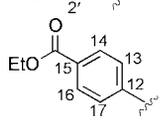
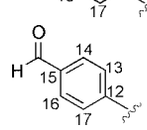
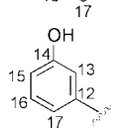
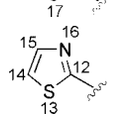
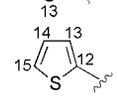
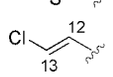
standard conditions to the desired internal alkynes in yields from 62 to 77% (Table 3, entries 1, 3, 4, 9, 10). Nevertheless, *O*-silylation and *O*-acylation of the 1,2-amino alcohol gave a considerable increase in yield (up to 92%, Table 3, entry 5). Moreover, no significant difference in reactivity between aryl iodides and aryl bromides was observed, although yields of coupling reactions with aryl bromides turned out to be slightly lower (Table 3, entries 6, 10, 12, 14, 15). Vinylic chlorides are inert for many coupling reactions.[23] We were pleased to find that TBDS-protected 10,11-didehydroquincoridine **20b** coupled smoothly when using diisopropylamine or piperidine instead of Et_3N (Table 3, entries 16 and 17).

Table 2 Sonogashira coupling of 10,11-didehydroquinidine with aryl and vinyl halides

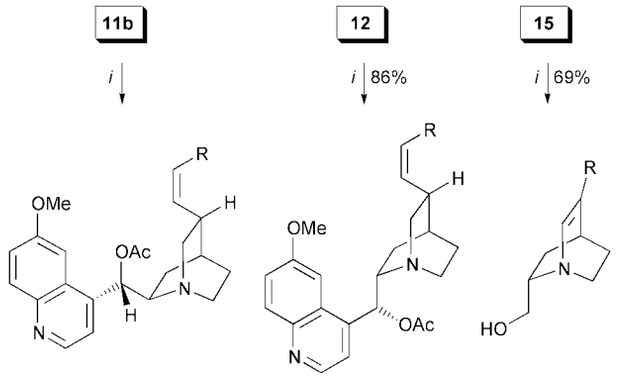
Entry	Alkyne	Ar-X	Internal alkyne	R^1	R^2[a]	Yield (%)
1	**9a**	R^2-Br	**21c**	H		77
2	**9b**	R^2-Br	**21d**	Ac		94
3	**9a**	R^2-Br	**21e**	H		67
4	**9b**	R^2-I	**21f**	Ac		86
5	**9b**	R^2-Br	**21g**	Ac		83
6	**9b**	R^2-Br	**21h**	Ac		90
7	**9b**	R^2-Br	**21i**	Ac		88
8	**9b**	R^2-I	**21j**	Ac		94
9	**9b**	R^2-I	**21k**	Ac		85
10	**9b**	R^2-I	**21l**	Ac		82
11	**9b**	R^2-I	**21m**	Ac		82
12	**9b**	R^2-I	**21n**	Ac		92
13	**9b**	R^2-I	**21o**	Ac		78
14	**9a**	R^2-I	**21p**	H		79
15	**9a**	R^2-I	**21q**	H		71

[a] Numbering shown is used in the NMR analysis.

Table 3 Sonogashira coupling of 10,11-didehydroquincorine **18a**–**c** and -quincoridine **20a**,**b** with various aryl and vinyl halides

Entry	Alkyne	Ar-X	Internal alkyne	R^1	R^2 [c]	Yield (%)
QCI-series						
1	**18a**	R^2-I	**23a**	H		74
2	**18b**	R^2-I	**23b**	TBDS		84
3	**18a**	R^2-I	**23c**	H		77
4	**18a**	R^2-I	**23d**	H		71
5	**18c**	R^2-I	**23e**	Bz		92
6	**18b**	R^2-Br	**23f**	TBDS		86
7	**18b**	R^2-I	**23g**	TBDS		84
8	**18b**	R^2-I	**23h**	TBDS		78 [a]
QCD-series						
9	**20a**	R^2-I	**24a**	H		65
10	**20a**	R^2-Br	**24b**	H		62
11	**20b**	R^2-I	**24c**	TBDS		91
12	**20b**	R^2-Br	**24d**	TBDS		82
13	**20b**	R^2-I	**24e**	TBDS		89
14	**20b**	R^2-Br	**24f**	TBDS		83
15	**20b**	R^2-Br	**24g**	TBDS		80
16	**20b**	R^2-Cl [b]	**24h**	TBDS		78
17	**20b**	R^2-Cl [b]	**24i**	TBDS		83

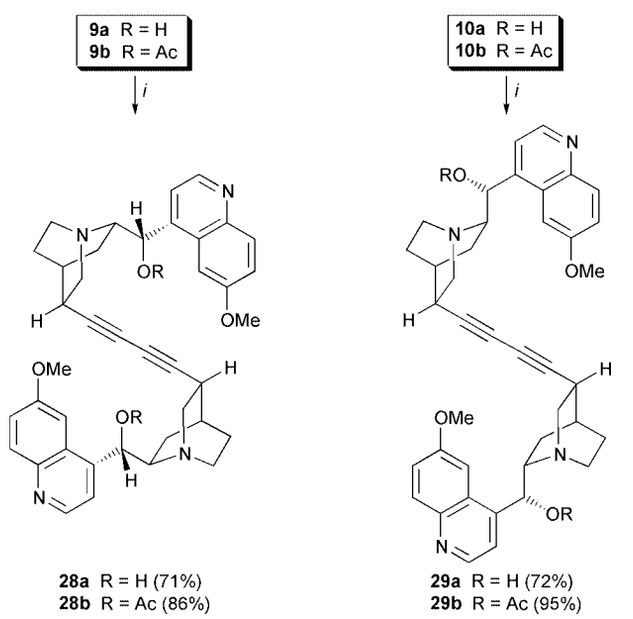
[a] Yield after cyclization to benzofuran **23h**. [b] Pr^i_2NH and piperidine were used instead of Et_3N. [c] Numbering shown is used in the NMR analysis.



Scheme 6 Sonogashira coupling of (*Z*)-vinyl iodides **11b**, **12** and vinylstannane **15** with alkylated alkynes. *Reagents and conditions*: *i*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), aryl or halide (1.0 eq.), THF, Et_3N, 16 h.

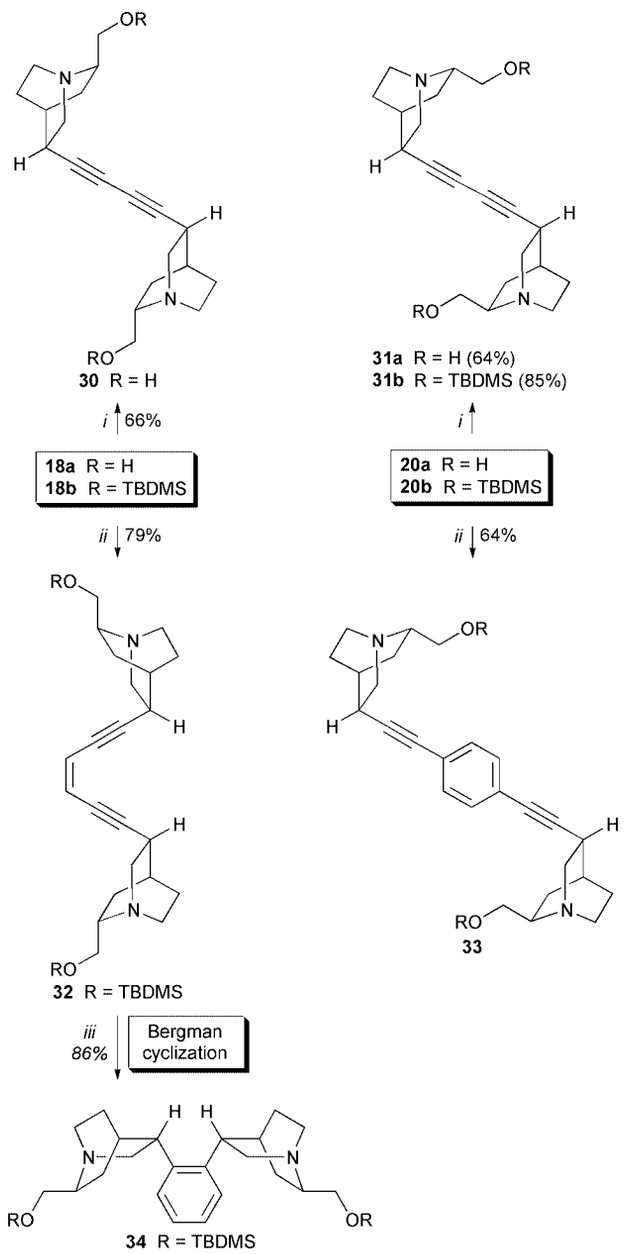
Quinidine- and quinine-based vinyl iodides **11a**,**b** and **12** coupled with terminal alkynes (Scheme 6) giving (*Z*)-enynes **25a**–**c** and **26** in fair yield (78–86%). Likewise, vinylstannane **15** was transformed into α-amino enyne **27**.

Homocoupling of 10,11-didehydro-quinidine and -quinine furnished the novel class of dimeric *Cinchona* alkaloids which are linked *via* the C10–C11-side chain. This is in contrast to AD-ligands of the second generation which incorporate heteroaromatic spacers (phthalazine or pyrimidine) between C9-oxygen atoms. A variety of synthetic methods is available for the homocoupling.[24] Although being suitable for the synthesis of porphyrin oligomers, the classic approach to diynes, the Glaser coupling, afforded the desired quinidine dimerics **28a**,**b** only in poor yield (<15%). Modified Sonogashira coupling was more suitable for the synthesis of symmetrical diynes **28** and **29**.[25] 10,11-Didehydroquinidine **9a**,**b** and 10,11-didehydroquinine **10a**,**b** underwent self-coupling in the presence of $(Ph_3P)_2PdCl_2$, CuI, I_2 (0.5 eq.) and Et_3N to give the corresponding diynes **28a**,**b** and **29a**,**b** exclusively (yields from 71 to 95%). The resulting products exhibit strongly enhanced basicity compared with parent quinine and quinidine (Scheme 7).



Scheme 7 Pd-mediated dimerization of 10,11-didehydroquinine and 10,11-didehydroquinidine. *Reagents and conditions*: *i*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), I_2 (0.5 eq.), THF, Et_3N, 16 h.

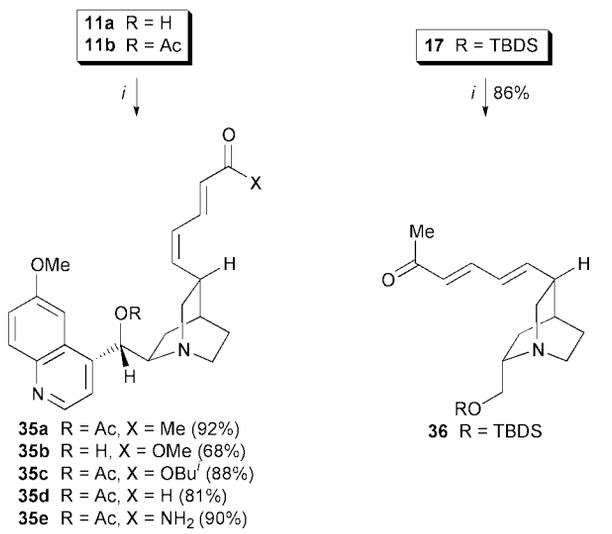
Homocoupling of simple 10,11-didehydroquincorine **18a** and 10,11-didehydroquincoridines **20a**,**b** afforded the corresponding diynes (64–85%) without by-products. Moreover, further spacers could be introduced giving enediyne **32** and quincoridine-based diyne **33** with a benzene spacer. Interestingly, enediyne **32** underwent a Bergman cycloaromatization at moderately elevated temperature (60–70 °C) in $CHCl_3$ (86% yield), although the enediyne moiety was not incorporated into a strained medium sized ring (Scheme 8).



Scheme 8 Pd-mediated dimerization of 10,11-didehydroquincorine and 10,11-didehydroquincoridine. *Reagents and conditions*: *i*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), I_2 (0.5 eq.), THF, Et_3N, 16 h; *ii*, $(Ph_3P)_2PdCl_2$ (0.05 eq.), CuI (0.1 eq.), 1,4-diiodobenzene or (*Z*)-1,2-dichloroethene (0.5 eq.), THF, Et_3N, 16 h; *iii*, $CHCl_3$, 60–70 °C, 4 h.

Over the years the Heck reaction has emerged as a powerful method for the formation of carbon–carbon bonds. Hallmarks of Heck reactions are excellent functional group tolerance and predictable regio- and stereochemistry. A telling indication of the utility of intramolecular Heck reactions is their recent use as the key step in the synthesis of many complex natural products, especially alkaloids.[26] Various protocols have been introduced, and tetraalkylammonium salts in particular have been highly successful in enhancing reactivity and selectivity of

inter- and intramolecular Heck-type reactions. We therefore used the optimized phase-transfer protocol developed by Jeffery ($Pd(OAc)_2$, K_2CO_3, *n*-Bu_4NI, DMF).[27] Under these conditions quinidine-(*Z*)-vinyl iodides **11a**,**b** and quincoridine-based (*E*)-vinyl iodide could be coupled stereoselectively with α,β-unsaturated carbonyl compounds to give conjugated alkenes **35a**–**e** and **36** at room temperature. *O*-Protection of the 1,2-amino alcohol unit was not essential. Heck coupling of vinyl iodide **11a** with methyl acrylate furnished dienoic ester **35b** (84%) (Scheme 9).



Scheme 9 Heck reactions of (*E*)- and (*Z*)-vinyl iodides. *Reagents and conditions*: *i*, $Pd(OAc)_2$ (0.05 eq.), K_2CO_3 (2.5 eq.), TBAI (1.0 eq.), α,β-unsatd. compound (4.0 eq.), DMF, RT, 12 h.

Conclusion

Cinchona alkaloid chemistry continues to contribute to medicinal chemistry, supramolecular chemistry[28] and asymmetric synthesis. As we have shown 10,11-didehydro *Cinchona* alkaloids represent a significantly new class of semi-natural *Cinchona* alkaloids[16] showing enhanced basicity and polarity. We have found that the C10–C11 triple bond facilitates crystallization including that of simple didehydro-QCI (**18a**) and didehydro-QCD (**20a**). These alkynes show also little twisting and considerable eclipsing of the ethano bridge of the azabicyclic cage (torsion angles $\Phi = 5$–$10°$ from X-ray crystal studies).[16] The additional functionality of the *Cinchona* alkaloid is tolerated by palladium-mediated cross-coupling without protection.

Experimental

General

Infrared spectra were recorded on a Perkin-Elmer 1710 infrared spectrometer. ^1H NMR and ^{13}C NMR spectra were recorded on Bruker AVS 400 and Bruker AVM 500 spectrometers in deuterated chloroform unless otherwise stated, with tetramethylsilane as internal standard. Mass spectra were recorded on a Finnigan MAT 312 (70 eV) or a VG Autospec spectrometer. Microanalyses were performed in the Department of Organic Chemistry of the University of Hannover. Preparative column chromatography was performed on J. T. Baker silica gel (particle size 30–60 μm). Analytical TLC was carried out on aluminium-backed 0.2 mm silica gel 60 F_{254} plates (E. Merck). Ethyl acetate (EA) and methyl *tert*-butyl ether (MTBE) were distilled before use. Methanol was dried over calcium hydride and citric acid and distilled over magnesium before use. Silver triflate was purchased from Aldrich, whereas silver benzoate was freshly prepared before use. Coupling precursors **9**–**12**, **18** and **20** were prepared as described previously.[16]

(1*S*,2*S*,4*S*)-2-Hydroxymethyl-5-tributylstannanyl-1-azabicyclo-[2.2.2]oct-5-ene 15

Ketone **14**[18] (1.0 eq.) and 2,4,6-triisopropylbenzenesulfonyl hydrazide (1.05 eq.) were dissolved in Et_2O at rt. The resulting yellow reaction mixture was stirred for 16 h at rt, sat. aq. $NaHCO_3$ was added and the aqueous layer was extracted with DCM. The collected organic layer was dried over $MgSO_4$, filtered and the solvent removed *in vacuo*. The residue was purified by column chromatography (EtOAc–MeOH 10:1) and redissolved (300 mg, 0.45 mmol, 1 eq.) in a 1:1 mixture of TMEDA (2 ml) and cyclohexane (2 ml). After stirring for 10 min at rt, the homogeneous solution was cooled to −78 °C and treated with *n*-BuLi (0.84 ml, 1.34 mmol, 3 eq.) and Bu_3SnCl (0.24 ml, 0.89 mmol, 2 eq.). The reaction mixture was stirred for 2 h at 0 °C, treated with sat. aq. $NaHCO_3$ and extracted with CH_2Cl_2. The collected organic layer was dried ($MgSO_4$), filtered and concentrated under reduced pressure. The resulting crude product was purified by column chromatography (EtOAc–MeOH 6:1) to afford vinylstannane **15** (80%, 152 mg, 0.36 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3304, 2960, 2929, 2872, 1564, 1463, 1419, 1379, 1362, 1342, 1292, 1230, 1150, 1082, 1050, 1007, 939 and 878; δ_H(400 MHz; $CDCl_3$) 6.93 (s, 1 H, H-6), 3.94–3.90 (m, 1 H, H-9), 3.81–3.74 (m, 1 H, H-9), 3.40–3.32 (m, 1 H, H-2), 2.90–2.76 (m, 2 H, H-7, H-7), 1.90–1.81 (m, 1 H, H-4), 1.62–1.54 (m, 2 H, H-3, H-8), 1.48–1.42 (m, 2 H, H-8, H-3), 1.32–1.16 (m, 9 H, Sn*Bu*$_3$) and 0.88–0.82 (m, 18 H, Sn*Bu*$_3$); δ_C(100 MHz; $CDCl_3$) 135.93 (CH, C-6), 121.95 (C, C-5), 62.61 (CH, C-2), 61.07 (CH_2, C-9), 43.16 (CH_2, C-7), 34.32 (CH, C-4), 29.37 (CH_2, $SnBu_3$), 28.15 (CH_2, $SnBu_3$), 27.12 (CH_2, $SnBu_3$), 26.93 (CH_2, $SnBu_3$), 26.19 (CH_2, C-8), 24.94 (CH_3, $SnBu_3$), 24.55 (CH_3, $SnBu_3$), 23.86 (CH_3, $SnBu_3$), 23.09 (CH_2, C-3), −9.02 (CH_2, $SnBu_3$), −9.13 (CH_2, $SnBu_3$) and −9.22 (CH_2, $SnBu_3$); *m*/*z* (MAT, 70 °C) (EI) 429.2054 (M^+, $C_{20}H_{39}N_1O_1{}^{120}Sn$ requires 429.2054), 313 ($M^+ - 2$ Bu, 15%), 292 (7), 269 (100), 239 (10), 213 (20), 195 (1), 177 (27), 155 (23) and 121 (12).

(1*S*,2*S*,4*S*,5*R*)-2-[(*tert*-Butyl)(dimethyl)silyloxymethyl]-5-[(*E*)-2-iodovinyl]-1-azabicyclo[2.2.2]octane 17

$CrCl_2$ (612 mg, 4.98 mmol, 8 eq.) was dissolved in absolute THF, cooled (0 °C) and treated with CHI_3 (490 mg, 1.24 mmol, 2 eq.). After 10 min TBDMS-protected C10-aldehyde **16**[29] (176 mg, 0.62 mmol, 1 eq.) was added at 0 °C and the resulting reaction mixture was stirred for 3 h at rt. After filtration over Celite® sat. aq. $NaHCO_3$, sat. aq. NaCl and H_2O were added and the aqueous layer was extracted with $CHCl_3$. The combined organic layer was dried ($MgSO_4$), filtered and concentrated *in vacuo*. Purification of the crude product by column chromatography (EtOAc–MeOH 20:1) furnished the desired vinyl iodide **17** (66%, 167 mg, 0.41 mmol, *E*:*Z* ratio: 81:19); $\nu_{max}(CHCl_3)/cm^{-1}$ 2956, 2932, 2900, 2860, 1672, 1604, 1460, 1408, 1388, 1256, 1228, 1172, 1132, 1092, 1064, 1004 and 948; δ_H(400 MHz; $CDCl_3$) 6.61–6.53 (m, 1 H, H-10), 6.41–6.37 (d, 1 H, *J* 14.5, H-11), 3.85–3.72 (m, 2 H, H-9, H-9), 3.62–3.54 (m, 1 H, H-2), 3.43–3.34 (m, 1 H, H-6), 3.32–3.24 (m, 1 H, H-6), 3.18–3.10 (m, 1 H, H-7), 3.08–2.97 (m, 1 H, H-7), 2.49–2.45 (m, 1 H, H-5), 2.28–2.22 (m, 1 H, H-4), 2.17–2.11 (m, 1 H, H-3), 2.10–1.93 (m, 1 H, H-8), 1.92–1.81 (m, 1 H, H-8), 1.80–1.71 (m, 1 H, H-3), 0.88 (s, 9 H, $SiC(CH_3)_3$) and 0.13–0.08 (m, 6 H, $SiCH_3$); δ_C(100 MHz; $CDCl_3$) 144.42 (CH, C-10), 79.65 (CH, C-11), 62.29 (CH_2, C-9), 58.79 (CH, C-2), 53.26 (CH_2, C-6), 43.81 (CH_2, C-7), 31.49 (CH, C-5), 27.85 (CH, C-4), 25.97 (CH_3, $SiC(CH_3)_3$), 23.91 (CH_2, C-8), 22.19 (CH_2, C-3), 18.22 (C, $SiC(CH_3)_3$), −5.14 (CH_3, $SiCH_3$) and −5.37 (CH_3, $SiCH_3$); *m*/*z* (FAB) (EI) 408 ($M^+ + H$, 100%), 394 (10), 282 (9), 221 (8), 207 (12), 147 (23) and 133 (19).

General procedure for the Sonogashira coupling of aryl and vinyl halides with terminal alkynes

$(Ph_3P)_2PdCl_2$ (0.05 eq.) and CuI (0.1 eq.) were dissolved in Et_3N and absolute THF (1 : 1 mixture, 10 ml $mmol^{-1}$ alkaloid). The reaction mixture was stirred for 15 min at rt under argon and a solution of the corresponding aryl or vinyl halide (1.5 eq.) in absolute THF was added. After stirring for 45 min at rt a solution of the terminal alkyne in absolute THF was added dropwise within 15 min. After having been stirred for 14–20 h at rt, the resulting orange–brown reaction mixture was treated with sat. aq. $NaHCO_3$ and sat. aq. NaCl. The aqueous layer was extracted several times with CH_2Cl_2 (up to 8×) and the combined organic layer was dried ($MgSO_4$) and concentrated under reduced pressure. The resulting crude product was purified by column chromatography (EtOAc–MeOH) to yield the desired internal alkyne.

(3*S*,4*S*,8*R*,9*S*)-11-Phenyl-10,11-didehydro-6′-methoxycinchonan-9-ol 21a. 10,11-Didehydroquinidine **9a** (644 mg, 2.00 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (70 mg, 0.10 mmol, 0.05 eq.), CuI (95 mg, 0.20 mmol, 0.1 eq.) and phenyl iodide (0.33 ml, 3.00 mmol, 1.5 eq.) to afford internal alkyne **21a** (80%, 637 mg, 1.60 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3064, 2944, 2876, 2836, 2224, 1620, 1592, 1508, 1472, 1432, 1388, 1364, 1320, 1256, 1228, 1172, 1092, 1032, 996 and 828; δ_H(400 MHz; $CDCl_3$) 8.55 (d, 1 H, *J* 4.6, H-2′), 7.93 (d, 1 H, *J* 9.1, H-8′), 7.47–7.42 (m, 3 H, H-3′, 2 Ar-H), 7.33–7.28 (m, 3 H, Ar-H), 7.27 (d, 1 H, *J* 2.6, H-5′), 7.24 (dd, 1 H, *J* 9.2 and 2.6, H-7′), 5.67 (d, 1 H, *J* 5.4, H-9), 3.80 (s, 3 H, H-11′), 3.54–3.49 (ddd, 1 H, *J* 13.6, 7.0 and 2.0, H-2_{endo}), 3.20–3.14 (m, 1 H, H-8), 3.11–3.05 (dd, 1 H, *J* 13.3 and 8.5, H-2_{exo}), 2.91–2.83 (m, 1 H, H-6), 2.75–2.65 (m, 2 H, H-6, H-3), 2.43–2.37 (m, 1 H, H-7), 2.09–2.05 (m, 1 H, H-4), 1.57–1.49 (m, 2 H, H-7, H-5) and 1.46–1.38 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 157.61 (C, C-6′), 147.62 (C, C-10′), 147.45 (CH, C-2′), 144.02 (C, C-4′), 131.63 (CH, Ar-H), 131.28 (CH, C-8′), 128.28 (CH, Ar-H), 127.77 (CH, Ar-H), 126.81 (C, C-9′), 123.69 (C, Ar-C), 121.52 (CH, C-7′), 118.74 (CH, C-3′), 101.39 (CH, C-5′), 92.68 (C, C-11), 81.70 (C, C-10), 71.41 (CH, C-9), 60.04 (CH, C-8), 55.64 (CH_3, C-11′), 50.61 (CH_2, C-2), 49.54 (CH_2, C-6), 28.81 (CH, C-3), 28.12 (CH, C-4), 25.03 (CH_2, C-7) and 22.94 (CH_2, C-5); *m*/*z* (MAT, 190 °C) (EI) 398.1999 (M^+, $C_{26}H_{26}N_2O_2$ requires 398.1994), 381 (3%), 369 (4), 341 (5), 326 (3), 312 (3), 283 (11), 262 (3), 240 (2), 226 (3), 210 (100), 200 (4), 189 (61), 172 (9), 155 (11), 128 (152), 115 (15), 91 (7) and 77 (9).

(3*S*,4*S*,8*S*,9*R*)-11-Phenyl-10,11-didehydro-6′-methoxycinchonan-9-ol 22a. 10,11-Didehydroquinine **10a** (200 mg, 0.62 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (22 mg, 0.03 mmol, 0.05 eq.), CuI (12 mg, 0.07 mmol, 0.1 eq.) and phenyl iodide (85 µl, 0.78 mmol, 1.3 eq.) to afford internal alkyne **22a** (70%, 173 mg, 0.43 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2952, 1622, 1592, 1509, 1491, 1473, 1432, 1265, 1241, 1230, 1083, 1031, 909 and 857; δ_H(400 MHz; $CDCl_3$) 8.50 (d, 1 H, *J* 4.6, H-2′), 7.86 (d, 1 H, *J* 10.0, H-8′), 7.51 (d, 1 H, *J* 4.5, H-3′), 7.21–7.10 (m, 5 H, H-7′, H-5′, Ar-H), 7.01–6.96 (m, 2 H, Ar-H), 5.67 (br s, 1 H, H-9), 3.77 (s, 3 H, H-11′), 3.76–3.68 (m, 1 H, H-8), 3.52–3.45 (m, 1 H, H-6_{endo}), 3.24 (dd, 1 H, *J* 13.3 and 10.0, H-2_{exo}), 3.05–2.98 (m, 1 H, H-2_{endo}), 2.77–2.66 (m, 2 H, H-6, H-3), 2.10 (m, 1 H, H-4), 1.91–1.69 (m, 3 H, H-7, H-7, H-5) and 1.54–1.45 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 157.79 (C, C-6′), 147.26 (CH, C-2′), 143.87 (C, C-10′, C-4′), 131.30 (CH, Ar-H), 131.02 (CH, C-8′), 128.12 (CH, Ar-H), 127.92 (CH, Ar-H), 127.76 (C, C-9′), 123.03 (C, Ar-C), 121.61 (CH, C-7′), 118.63 (CH, C-3′), 101.18 (CH, C-5′), 92.16 (C, C-11), 81.49 (C, C-10), 70.58 (CH, C-9), 59.42 (CH, C-8), 57.82 (CH_2, C-2), 55.83 (CH_3, C-11′), 42.90 (CH_2, C-6), 28.11 (CH, C-3), 27.22 (CH, C-4), 25.40 (CH_2, C-5) and 21.59 (CH_2, C-7); *m*/*z* (MAT, 180 °C) (EI) 398.1994 (M^+, $C_{26}H_{26}N_2O_2$ requires 398.1994), 381 (3%), 341 (8), 326 (5), 283 (13) and 210 (100).

(3*S*,4*S*,8*S*,9*R*)-9-Acetoxy-11-phenyl-10,11-didehydro-6′-methoxycinchonan 22b. 10,11-Didehydroquinine **10b** (130 mg, 0.35 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and phenyl iodide (50 µl, 0.46 mmol, 1.3 eq.) to afford internal alkyne **22b** (86%, 135 mg, 0.31 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2952, 2868, 1744, 1620, 1508, 1472, 1432, 1372, 1232, 1084, 1032 and 852; δ_H(400 MHz; $CDCl_3$) 8.80 (d, 1 H, *J* 4.6, H-2′), 8.07 (d, 1 H, *J* 9.2, H-8′), 7.50 (d, 1 H, *J* 2.8, H-5′), 7.44 (d, 1 H, *J* 4.6, H-3′), 7.42 (dd, 1 H, *J* 9.3 and 2.6, H-7′), 7.36–7.29 (m, 5 H, Ar-H), 6.55 (d, 1 H, *J* 7.7, H-9), 3.95 (s, 3 H, H-11′), 3.76–3.69 (m, 1 H, H-8), 3.23 (dd, 1 H, *J* 13.6 and 10.0, H-2_{exo}), 3.19–3.12 (m, 1 H, H-6), 2.93–2.91 (m, 1 H, H-2_{endo}), 2.78–2.67 (m, 2 H, H-6, H-3), 2.29–2.22 (m, 1 H, H-7), 2.19 (s, 3 H, H-13), 2.17 (br s, 1 H, H-4), 1.83–1.76 (m, 1 H, H-5) and 1.64–1.51 (m, 2 H, H-7, H-5); δ_C(100 MHz; $CDCl_3$) 170.14 (C, C-12), 157.89 (C, C-6′), 147.48 (CH, C-2′), 144.82 (C, C-4′), 143.46 (C, C-10′), 131.81 (CH, C-8′), 131.50 (CH, C-Ar), 128.24 (CH, Ar-H), 127.75 (CH, Ar-H), 127.04 (C, C-9′), 123.57 (C, Ar-C), 121.82 (CH, C-7′), 119.19 (CH, C-3′), 101.53 (CH, C-5′), 93.24 (C, C-11), 81.06 (C, C-10), 73.73 (CH, C-9), 58.54 (CH, C-8), 58.00 (CH_2, C-2), 55.57 (CH_3, C-11′), 41.93 (CH_2, C-6), 28.37 (CH, C-3), 27.06 (CH, C-4), 26.23 (CH_2, C-5), 24.99 (CH_2, C-7) and 21.10 (CH_3, C-13); *m*/*z* (MAT, 140 °C) (EI) 440.2105 (M^+, $C_{28}H_{28}N_2O_3$ requires 440.2099), 398 (2%), 381 (8), 330 (3), 280 (14), 277 (16), 231 (16), 210 (62), 204 (96), 189 (18), 167 (34), 149 (90) and 77 (100).

(3*S*,4*S*,8*R*,9*S*)-11-(3″-Quinolyl)-10,11-didehydro-6′-methoxycinchonan-9-ol 21c. 10,11-Didehydroquinidine **9a** (644 mg, 2.00 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (70 mg, 0.10 mmol, 0.05 eq.), CuI (95 mg, 0.20 mmol, 0.1 eq.) and 3-bromoquinoline (0.41 ml, 3.00 mmol, 1.5 eq.) to afford internal alkyne **21c** (77%, 691 mg, 1.54 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3340, 3068, 2948, 2876, 2220, 1620, 1592, 1508, 1488, 1472, 1432, 1388, 1360, 1340, 1320, 1256, 1240, 1172, 1092, 1032, 908 and 828; δ_H(400 MHz; $CDCl_3$) 8.69 (d, 1 H, *J* 1.9, H-2″), 8.55 (d, 1 H, *J* 4.6, H-2′), 8.12 (d, 1 H, *J* 1.9, H-4″), 8.06 (d, 1 H, *J* 8.5, H-8″), 7.97 (d, 1 H, *J* 9.3, H-8′), 7.69 (d, 1 H, *J* 8.0, H-5″), 7.66 (ddd, 1 H, *J* 8.4, 6.9 and 1.5, H-7″), 7.57 (d, 1 H, *J* 4.5, H-3′), 7.51–7.48 (ddd, 1 H, *J* 8.0, 6.9 and 1.1, H-6″), 7.34 (d, 1 H, *J* 2.6, H-5′), 7.27 (dd, 1 H, *J* 9.2, 2.6, H-7′), 5.68 (d, 1 H, *J* 5.4, H-9), 3.80 (s, 3 H, H-11′), 3.61–3.54 (m, 1 H, H-2_{endo}), 3.25–3.19 (m, 1 H, H-8), 3.14–3.07 (dd, 1 H, *J* 13.4 and 10.4, H-2_{exo}), 2.94–2.85 (m, 1 H, H-6), 2.76–2.69 (m, 1 H, H-6), 2.46–2.40 (m, 1 H, H-3), 2.14–2.09 (m, 1 H, H-4), 1.65–1.47 (m, 3 H, H-7, H-7, H-5) and 1.35–1.26 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 157.58 (C, C-6′), 152.30 (CH, C-6″), 147.99 (C, C-10′), 147.50 (CH, C-2′), 146.30 (C, C-10″), 144.17 (C, C-4′), 138.15 (CH, C-2″), 131.37 (CH, C-8′), 129.85 (CH, C-8″), 128.99 (CH, C-7″), 127.43 (CH, C-5″), 127.27 (C, C-9″), 127.23 (CH, C-4″), 126.96 (C, C-9′), 121.43 (CH, C-7′), 118.97 (CH, C-3′), 117.90 (C, C-3″), 101.70 (CH, C-5′), 96.57 (C, C-11), 78.80 (C, C-10), 71.71 (CH, C-9), 60.08 (CH, C-8), 55.59 (CH_3, C-11′), 50.44 (CH_2, C-2), 49.54 (CH_2, C-6), 29.09 (CH, C-3), 28.19 (CH, C-4), 25.07 (CH_2, C-7) and 23.31 (CH_2, C-5); *m*/*z* (MAT, 180 °C) (EI) 449.2108 (M^+, $C_{29}H_{27}N_3O_2$ requires 449.2103), 434 (7%), 421 (8), 392 (7), 378 (7), 363 (7), 283 (18), 261 (100), 249 (8), 233 (26), 220 (15), 206 (19), 189 (45), 179 (16), 167 (14), 158 (11), 128 (10), 117 (10), 91 (17) and 82 (10).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(3″-quinolyl)-10,11-didehydro-6′-methoxycinchonan 21d. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol,

0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 3-bromoquinoline (0.07 ml, 0.54 mmol, 1.5 eq.) to afford quininyl-substituted alkyne **21d** (94%, 165 mg, 0.34 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2952, 2876, 2224, 1744, 1620, 1592, 1508, 1472, 1456, 1432, 1372, 1320, 1300, 1264, 1232, 1136, 1092, 1032 and 908; δ_H(400 MHz; $CDCl_3$) 9.03 (d, 1 H, *J* 2.0, H-2″), 8.81 (d, 1 H, *J* 4.4, H-2′), 8.37 (d, 1 H, *J* 1.9, H-4″), 8.16 (d, 1 H, *J* 8.4, H-8″), 8.08 (d, 1 H, *J* 9.2, H-8′), 7.85 (d, 1 H, *J* 8.1, H-5″), 7.83 (ddd, 1 H, *J* 8.4, 7.0 and 1.5, H-7″), 7.63–7.56 (ddd, 1 H, *J* 8.1, 7.0 and 1.1, H-6″), 7.55 (d, 1 H, *J* 2.6, H-5′), 7.45 (d, 1 H, *J* 4.6, H-3′), 7.41 (dd, 1 H, *J* 9.2 and 2.7, H-7′), 6.78 (d, 1 H, *J* 7.2, H-9), 3.89 (s, 3 H, H-11′), 3.47–3.41 (m, 1 H, H-8), 3.29–3.23 (m, 1 H, H-2_{endo}), 3.19–3.12 (dd, 1 H, *J* 13.8 and 8.5, H-2_{exo}), 2.92–2.74 (m, 2 H, H-6, H-6), 2.33–2.27 (m, 1 H, H-3), 2.21–2.17 (m, 1 H, H-4), 2.16 (s, 3 H, H-13), 1.76–1.55 (m, 3 H, H-7, H-7, H-5) and 1.36–1.25 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 169.91 (C, C-12), 157.99 (C, C-6′), 152.43 (CH, C-6″), 147.49 (CH, C-2′), 146.64 (C, C-10″), 144.71 (C, C-10′), 143.56 (C, C-4′), 138.29 (CH, C-2″), 131.77 (CH, C-8′), 129.90 (CH, C-8″), 129.34 (CH, C-7″), 127.52 (CH, C-5″), 127.36 (C, C-9″), 127.28 (CH, C-4″), 127.03 (C, C-9′), 121.91 (CH, C-7′), 118.87 (CH, C-3′), 117.82 (C, C-3″), 101.43 (CH, C-5′), 96.38 (C, C-11), 79.18 (C, C-10), 73.45 (CH, C-9), 58.94 (CH, C-8), 55.52 (CH_3, C-11′), 50.39 (CH_2, C-2), 49.49 (CH_2, C-6), 29.09 (CH, C-3), 27.81 (CH, C-4), 25.05 (CH_2, C-7), 24.42 (CH_2, C-5) and 21.14 (CH_3, C-13); *m*/*z* (MAT, 180 °C) (EI) 491.2197 (M^+, $C_{31}H_{29}N_3O_3$ requires 491.2195), 476 (9%), 448 (11), 432 (26), 421 (8), 402 (8), 392 (9), 375 (9), 325 (22), 284 (8), 261 (100), 245 (10), 233 (34), 220 (14), 204 (22), 189 (37), 179 (20), 166 (17), 154 (13), 128 (11), 117 (8), 94 (11) and 82 (10).

(3*S*,4*S*,8*R*,9*S*)-10,11-Didehydro-11-(2-naphthyl)-6′-methoxycinchonan-9-ol 21e. 10,11-Didehydroquinidine **9a** (130 mg, 0.40 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (14 mg, 0.02 mmol, 0.05 eq.), CuI (8 mg, 0.04 mmol, 0.1 eq.) and 3-bromonaphthalene (125 mg, 0.61 mmol, 1.5 eq.) to afford naphthyl-substituted alkyne **21e** (67%, 121 mg, 0.27 mmol); ν_{max}($CHCl_3$)/cm^{-1} 3412, 3084, 2948, 2876, 1620, 1592, 1508, 1472, 1432, 1388, 1364, 1320, 1240, 1188, 1104, 1032, 844 and 832; δ_H(400 MHz; $CDCl_3$) 8.46 (d, 1 H, *J* 4.6, H-2′), 7.90–7.82 (m, 3 H, H-8′, 2 naphthyl-H), 7.41 (d, 1 H, *J* 4.5, H-3′), 7.33–7.20 (m, 5 H, H-5′, H-7′, 3 naphthyl-H), 6.80–6.59 (m, 2 H, naphthyl-H), 5.76 (s, 1 H, H-9), 3.84 (s, 3 H, H-11′), 3.68–3.63 (m, 1 H, H-8), 3.11–3.02 (m, 1 H, H-2), 2.98–2.81 (m, 2 H, H-2, H-6), 2.73–2.59 (m, 1 H, H-6), 2.38–2.30 (m, 1 H, H-3), 1.98–1.92 (m, 1 H, H-4), 1.56–1.39 (m, 3 H, H-7, H-7, H-5) and 1.31–1.14 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 157.82 (C, C-6′), 147.69 (C, C-10′), 147.37 (CH, C-2′), 143.81 (C, C-4′), 133.44 (C, C-13), 133.28 (C, C-18), 131.17 (CH, C-8′), 130.21 (CH, C-12), 130.09 (C, C-21), 128.69–126.88 (CH, C-14, C-15, C-16, C-17, C-19, C-20), 126.54 (C, C-9′), 121.69 (CH, C-7′), 118.98 (CH, C-3′), 101.26 (CH, C-5′), 96.42 (C, C-11), 80.09 (C, C-10), 69.98 (CH, C-9), 59.82 (CH, C-8), 55.87 (CH_3, C-11′), 49.29 (CH_2, C-2), 46.63 (CH_2, C-6), 29.98 (CH, C-3), 27.88 (CH, C-4), 24.34 (CH_2, C-7) and 22.58 (CH_2, C-5); *m*/*z* (MAT, 50 °C) (EI) 448.2151 (M^+, $C_{30}H_{28}N_2O_2$ requires 448.2151), 442 (6%), 426 (4), 411 (3), 399 (3), 373 (3), 355 (2), 321 (4), 284 (5), 267 (12), 254 (8), 239 (7), 202 (5), 189 (31), 173 (18), 160 (22), 129 (7), 116 (10), 99 (12) and 83 (100).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-10,11-didehydro-11-(4-ethoxycarbonylphenyl)-6′-methoxycinchonan 21f. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 4-iodobenzoate (127 mg, 0.53 mmol, 1.5 eq.) to afford ethoxycarbonylphenyl-substituted alkyne **21f** (86%, 157 mg, 0.31 mmol); ν_{max}($CHCl_3$)/cm^{-1} 3076, 2944, 2876, 2220, 1740, 1712, 1620, 1604, 1508, 1472, 1432, 1368, 1276, 1228, 1176, 1108, 1068, 1028, 856 and 824; δ_H(400 MHz; $CDCl_3$) 8.77 (d, 1 H, *J* 4.5, H-2′), 8.07 (d, 2 H, *J* 8.4, H-14, H-16), 8.06 (d, 1 H, *J* 9.2, H-8′), 7.61 (d, 2 H, *J* 8.6, H-13, H-17), 7.52 (d, 1 H, *J* 2.6, H-5′), 7.42 (d, 1 H, *J* 4.6, H-3′), 7.40 (dd, 1 H, *J* 9.2 and 2.6, H-7′), 6.73 (d, 1 H, *J* 7.0, H-9), 4.44 (q, 2 H, *J* 7.1, H_3C-H_2C-O), 3.89 (s, 3 H, H-11′), 3.43–3.36 (m, 1 H, H-8), 3.24–3.18 (m, 1 H, H-2), 3.14–3.08 (dd, 1 H, *J* 13.8 and 10.1, H-2_{exo}), 2.91–2.83 (m, 1 H, H-6), 2.81–2.72 (m, 1 H, H-6), 2.29–2.22 (m, 1 H, H-3), 2.14 (s, 3 H, H-20), 2.15–2.10 (m, 1 H, H-4), 1.71–1.55 (m, 3 H, H-7, H-7, H-5), 1.45–1.41 (t, 3 H, *J* 7.1, H_3C-H_2C-O) and 1.32–1.28 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 169.90 (C, C-19), 166.14 (C, C-18), 157.97 (C, C-6′), 148.19 (C, C-15), 147.39 (CH, C-2′), 144.62 (C, C-10′), 143.59 (C, C-4′), 131.75 (CH, C-8′), 131.56 (2 CH, C-14, C-16), 129.52 (2 CH, C-13, C-17), 129.50 (C, C-12), 128.38 (C, C-9′), 121.96 (CH, C-7′), 118.76 (CH, C-3′), 101.35 (CH, C-5′), 96.09 (C, C-11), 81.33 (C, C-10), 73.57 (CH, C-9), 61.13 (CH_2, H_3C-H_2C-O), 58.97 (CH, C-8), 55.52 (CH_3, C-11′), 50.42 (CH_2, C-2), 49.50 (CH_2, C-6), 29.05 (CH, C-3), 27.76 (CH, C-4), 25.08 (CH_2, C-7), 24.38 (CH_2, C-5), 21.09 (CH_3, C-20) and 14.32 (CH_3, H_3C-H_2C-O); *m*/*z* (MAT, 180 °C) (EI) 512.2335 (M^+, $C_{31}H_{32}N_2O_5$ requires 512.2331), 497 (5%), 467 (10), 453 (30), 439 (6), 414 (9), 379 (4), 365 (18), 340 (4), 325 (22), 305 (8), 283 (100), 254 (19), 231 (34), 226 (8), 209 (9), 189 (44), 171 (18), 155 (18), 136 (14), 115 (10), 91 (7) and 77 (9).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-10,11-didehydro-11-(4-formylphenyl)-6′-methoxycinchonan 21g. 10,11-Didehydroquinidine **9b** (195 mg, 0.54 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (19 mg, 0.03 mmol, 0.05 eq.), CuI (10 mg, 0.05 mmol, 0.1 eq.) and 4-bromobenzaldehyde (149 mg, 0.80 mmol, 1.5 eq.) to afford *p*-benzaldehyde-substituted alkyne **21g** (83%, 208 mg, 0.44 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2948, 2876, 2836, 2220, 1744, 1700, 1620, 1600, 1508, 1472, 1456, 1432, 1372, 1304, 1232, 1164, 1092, 1068, 1032 and 832; δ_H(400 MHz; $CDCl_3$) 10.05 (s, 1 H, H-18), 8.79 (d, 1 H, *J* 4.4, H-2′), 8.07 (d, 1 H, *J* 9.2, H-8′), 7.91 (d, 2 H, *J* 8.4, H-14, H-16), 7.71 (d, 2 H, *J* 8.4, H-13, H-17), 7.53 (d, 1 H, *J* 2.7, H-5′), 7.43 (d, 1 H, *J* 4.6, H-3′), 7.41 (dd, 1 H, *J* 9.4 and 2.7, H-7′), 6.73 (d, 1 H, *J* 7.3, H-9), 3.90 (s, 3 H, H-11′), 3.46–3.39 (m, 1 H, H-8), 3.24–3.19 (ddd, 1 H, *J* 14.0, 6.8 and 2.0, H-2_{endo}), 3.15–3.09 (dd, 1 H, *J* 14.0 and 10.4, H-2_{exo}), 2.91–2.72 (m, 3 H, H-6, H-6, H-3), 2.27–2.19 (m, 1 H, H-4), 2.15 (s, 3 H, H-20), 1.74–1.58 (m, 3 H, H-7, H-7, H-5) and 1.31–1.27 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 191.42 (CH, C-18), 169.92 (C, C-19), 157.94 (C, C-6′), 147.48 (CH, C-2′), 144.80 (C, C-10′), 143.49 (C, C-4′), 135.21 (C, C-15), 132.23 (2 CH, C-14, C-16), 131.83 (CH, C-8′), 130.12 (C, C-12), 129.59 (2 CH, C-13, C-17), 127.02 (C, C-9′), 121.86 (CH, C-7′), 118.89 (CH, C-3′), 101.44 (CH, C-5′), 97.44 (C, C-11), 81.28 (C, C-10), 73.49 (CH, C-9), 58.97 (CH, C-8), 55.49 (CH_3, C-11′), 50.30 (CH_2, C-2), 49.46 (CH_2, C-6), 29.11 (CH, C-3), 27.75 (CH, C-4), 25.06 (CH_2, C-7), 24.55 (CH_2, C-5) and 21.08 (CH_3, C-20); *m*/*z* (MAT, 190 °C) (EI) 468.2050 (M^+, $C_{29}H_{28}N_2O_4$ requires 468.2049), 453 (4%), 440 (2), 425 (8), 410 (26), 381 (3), 370 (4), 355 (2), 326 (26), 307 (2), 296 (4), 283 (3), 253 (7), 238 (100), 231 (21), 210 (9), 188 (44), 172 (14), 155 (19), 128 (11), 115 (14), 91 (7) and 77 (10).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-10,11-didehydro-11-(thiazolin-2-yl)-6′-methoxycinchonan 21h. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-bromothiazole (48 µl, 0.54 mmol, 1.5 eq.) to yield thiazolinyl-substituted alkyne **21h** (90%, 144 mg, 0.32 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2948, 2876, 2220, 1744, 1620, 1592, 1508, 1476, 1456, 1432, 1372, 1320, 1304, 1232, 1136, 1088, 1056, 1032 and 844; δ_H(400 MHz; $CDCl_3$) 8.79 (d, 1 H, *J* 4.6, H-2′), 8.08 (d, 1 H, *J* 9.0, H-8′), 7.86 (d, 1 H, *J* 3.3, H-13), 7.44–7.40 (m, 3 H, H-5′, H-3′, H-7′), 7.38 (d, 1 H, *J* 3.3, H-14), 6.63 (d, 1 H, *J* 6.1, H-9), 3.98 (s, 3 H, H-11′), 3.38–3.27 (m, 2 H, H-8, H-2), 3.21–3.15 (dd, 1 H, *J* 14.0 and 10.2,

H-2$_{exo}$), 2.90–2.73 (m, 2 H, H-6, H-6), 2.33–2.26 (m, 1 H, H-3), 2.22–2.18 (m, 1 H, H-4), 2.20 (s, 3 H, H-16), 1.64–1.56 (m, 3 H, H-7, H-7, H-5) and 1.37–1.28 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 169.85 (C, C-15), 157.99 (C, C-6′), 149.09 (C, C-12), 147.48 (CH, C-2′), 144.67 (C, C-10′), 143.69 (C, C-4′), 143.29 (CH, C-13), 131.85 (CH, C-8′), 126.76 (C, C-9′), 121.92 (CH, C-7′), 120.14 (CH, C-14), 118.32 (CH, C-3′), 101.25 (CH, C-5′), 98.31 (C, C-11), 75.07 (C, C-10), 73.91 (CH, C-9), 58.91 (CH, C-8), 55.66 (CH_3, C-11′), 49.92 (CH_2, C-2), 49.58 (CH_2, C-6), 29.11 (CH, C-3), 27.66 (CH, C-4), 24.92 (CH_2, C-7), 23.77 (CH_2, C-5) and 21.18 (CH_3, C-16); *m*/*z* (MAT, 190 °C) (EI) 447.1602 (M^+, $C_{25}H_{25}N_3O_3S$ requires 447.1606), 432 (2%), 404 (9), 388 (49), 372 (2), 348 (8), 325 (12), 297 (4), 265 (4), 253 (4), 231 (10), 217 (100), 202 (6), 188 (37), 172 (11), 162 (11), 132 (15), 117 (7), 104 (9) and 77 (9).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-10,11-didehydro-11-(2-thienyl)-6′-methoxycinchonan 21i. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-bromothiophene (52 µl, 0.53 mmol, 1.5 eq.) to yield thiophenyl-substituted alkyne **21i** (88%, 140 mg, 0.31 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2956, 2876, 2224, 1744, 1620, 1592, 1508, 1472, 1456, 1432, 1372, 1300, 1236, 1136, 1092, 1028, 988, 844 and 828; δ_H(400 MHz; $CDCl_3$) 8.79 (d, 1 H, *J* 4.6, H-2′), 8.07 (d, 1 H, *J* 9.0, H-8′), 7.51 (d, 1 H, *J* 2.6, H-5′), 7.43–7.39 (m, 2 H, H-3′, H-7′), 7.29–7.26 (m, 2 H, H-13, H-15), 7.04 (dd, 1 H, *J* 5.3 and 3.7, H-14), 6.71 (d, 1 H, *J* 6.4, H-9), 3.95 (s, 3 H, H-11′), 3.42–3.33 (m, 1 H, H-8), 3.26–3.20 (m, 1 H, H-2), 3.07–2.99 (m, 1 H, H-2), 2.92–2.74 (m, 2 H, H-6, H-6), 2.32–2.24 (m, 1 H, H-3), 2.16–2.11 (m, 1 H, H-4), 2.19 (s, 3 H, H-17), 1.67–1.54 (m, 3 H, H-7, H-7, H-5) and 1.37–1.28 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 169.88 (C, C-16), 158.01 (C, C-6′), 147.42 (CH, C-2′), 144.38 (C, C-10′), 143.73 (C, C-4′), 131.77 (CH, C-8′), 131.43 (CH, C-15), 128.59 (C, C-12), 126.96 (C, C-9′), 126.29 (CH, C-13), 122.01 (CH, C-7′), 120.14 (CH, C-14), 118.53 (CH, C-3′), 101.29 (CH, C-5′), 96.71 (C, C-11), 74.87 (C, C-10), 73.79 (CH, C-9), 59.01 (CH, C-8), 55.57 (CH_3, C-11′), 50.49 (CH_2, C-2), 49.59 (CH_2, C-6), 29.24 (CH, C-3), 27.83 (CH, C-4), 25.11 (CH_2, C-7), 24.13 (CH_2, C-5) and 21.14 (CH_3, C-17); *m*/*z* (MAT, 140 °C) (EI) 446.1186 (M^+, $C_{26}H_{26}N_2O_3S$ requires 446.1188), 366 (10%), 324 (7), 306 (4), 278 (7), 262 (4), 231 (2), 216 (6), 201 (3), 183 (5), 167 (11), 149 (19), 136 (10), 115 (50), 101 (17), 86 (100) and 72 (37).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(6,6,7-trimethyl-2,3,3a,3b,4,7,7a,8a-octahydrofuro[2,3-*b*]benzofuryl)-10,11-didehydro-6′-methoxycinchonan 21j. 10,11-Didehydroquinidine **9b** (73 mg, 0.20 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (8 mg, 0.01 mmol, 0.05 eq.), CuI (4 mg, 0.02 mmol, 0.1 eq.) and the tricyclic vinyl iodide (100 mg, 0.30 mmol, 1.5 eq.) to yield substituted alkyne **21j** (94%, 107 mg, 0.19 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2960, 2940, 2884, 1744, 1620, 1592, 1508, 1472, 1456, 1368, 1304, 1228, 1136, 1108, 1084, 1040, 996, 940 and 852; δ_H(400 MHz; $CDCl_3$) 8.82 (d, 1 H, *J* 4.6, H-2′), 8.13 (d, 1 H, *J* 9.2, H-8′), 7.49 (d, 1 H, *J* 2.6, H-5′), 7.44–7.40 (dd, 1 H, *J* 9.2 and 2.6, H-7′), 7.39 (d, 1 H, *J* 4.6, H-3′), 6.69 (d, 1 H, *J* 6.3, H-9), 5.73 (d, 1 H, *J* 4.8, H-20), 4.18–4.13 (m, 1 H, H-22), 4.02 (s, 3 H, H-11′), 3.85–3.78 (m, 1 H, H-18), 3.69–3.61 (m, 1 H, H-18), 3.32–3.21 (m, 2 H, H-8, H-2), 3.00–2.93 (m, 1 H, H-2), 2.90–2.74 (m, 2 H, H-6, H-6), 2.62–2.54 (m, 1 H, H-3), 2.22 (s, 3 H, H-25), 2.15–2.02 (m, 3 H, H-4, H-15, H-16), 1.94–1.87 (m, 1 H, H-7), 1.85–1.67 (m, 2 H, H-7, H-5), 1.62–1.53 (m, 4 H, H-17, H-17, H-23, H-23), 1.32–1.28 (m, 1 H, H-5), 1.13 (s, 3 H, C-13-*Me*), 1.04 (s, 3 H, C-14-*Me*) and 1.03 (s, 3 H, C-14-*Me*); δ_C(100 MHz; $CDCl_3$) 169.76 (C, C-24), 158.21 (C, C-6′), 147.89 (CH, C-2′), 147.40 (C, C-10′), 144.59 (C, C-4′), 132.17 (C, C-13), 131.71 (CH, C-8′), 126.89 (C, C-9′), 122.09 (CH, C-7′), 118.53 (CH, C-3′), 112.11 (C, C-12), 109.66 (CH, C-20), 101.45 (CH, C-5′), 98.02 (C, C-11), 82.05 (C, C-10), 77.25 (CH, C-22), 71.74 (CH, C-9), 70.06 (CH_2, C-18), 58.39 (CH, C-8), 58.14 (CH_2, C-2), 53.60 (CH_3, C-11′), 49.26 (CH_2, C-6), 44.89 (CH, C-15), 39.33 (C, C-14), 37.89 (CH, C-16), 28.27 (CH, C-3), 27.28 (CH, C-4), 26.53 (CH_2, C-7), 25.81 (CH_2, C-23), 24.19 (CH_2, C-17), 23.27 (CH_2, C-5), 21.16 (CH_3, C-25), 16.37 (CH_3, C-13-*Me*), 15.59 (CH_3, C-14-*Me*) and 15.57 (CH_3, C-14-*Me*); *m*/*z* (MAT, 220 °C) (EI) 570.3127 (M^+, $C_{35}H_{42}N_2O_5$: requires 570.3134), 556 (9%), 528 (6), 512 (31), 340 (100), 325 (12), 312 (17), 298 (13), 285 (11), 251 (7), 231 (61), 211 (9), 189 (59), 172 (28), 160 (17), 136 (15), 121 (70), 105 (11) and 91 (28.95).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-10,11-didehydro-11-(4-hydroxyphenyl)-6′-methoxycinchonan 21k. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 4-iodophenol (117 mg, 0.53 mmol, 1.5 eq.) to yield *p*-hydroxyphenyl-substituted alkyne **21k** (85%, 138 mg, 0.30 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3420, 2940, 2876, 1744, 1620, 1592, 1508, 1472, 1456, 1368, 1304, 1236, 1136, 1084, 1064, 1028, 984, 916 and 844; δ_H(400 MHz; $CDCl_3$) 8.75 (d, 1 H, *J* 4.6, H-2′), 8.04 (d, 1 H, *J* 9.2, H-8′), 7.92 (d, 2 H, *J* 8.4, H-14, H-16), 7.59 (d, 2 H, *J* 8.4, H-13, H-17), 7.43 (d, 1 H, *J* 2.6, H-5′), 7.40–7.37 (dd, 1 H, *J* 9.2 and 2.6, H-7′), 7.36 (d, 1 H, *J* 4.7, H-3′), 6.57 (d, 1 H, *J* 6.8, H-9), 3.97 (s, 3 H, H-11′), 3.32–3.26 (m, 1 H, H-8), 2.95–2.92 (d, 1 H, *J* 14.4, H-2), 2.93–2.69 (m, 3 H, H-2, H-6, H-6), 2.32–2.26 (m, 1 H, H-3), 2.15 (s, 3 H, H-19), 2.16–2.08 (m, 1 H, H-4), 1.94–1.78 (m, 2 H, H-7, H-7) and 1.57–1.44 (m, 2 H, H-5, H-5); δ_C(100 MHz; $CDCl_3$) 169.93 (C, C-18), 166.34 (C, C-15), 157.93 (C, C-6′), 147.37 (CH, C-2′), 144.63 (C, C-10′), 143.85 (C, C-4′), 131.69 (CH, C-8′), 131.55 (CH, C-14, C-16), 129.48 (C, C-12), 128.19 (CH, C-13, C-17), 126.99 (C, C-9′), 121.88 (CH, C-7′), 118.51 (CH, C-3′), 101.39 (CH, C-5′), 96.13 (C, C-11), 81.97 (C, C-10), 73.59 (CH, C-9), 59.03 (CH, C-8), 55.62 (CH_3, C-11′), 49.98 (CH_2, C-2), 49.16 (CH_2, C-6), 31.25 (CH, C-3), 27.87 (CH, C-4), 26.35 (CH_2, C-7), 23.28 (CH_2, C-5) and 21.14 (CH_3, C-19); *m*/*z* (MAT, 200 °C) (EI) 456 (M^+, 7%), 455 (25), 397 (6), 369 (10), 355 (5), 325 (17), 313 (5), 297 (3), 279 (17), 258 (7), 231 (17), 226 (12), 197 (100), 183 (12), 168 (18), 143 (13), 123 (4), 105 (12) and 91 (16).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-10,11-didehydro-11-(3-hydroxyphenyl)-6′-methoxycinchonan 21l. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 3-iodophenol (117 mg, 0.53 mmol, 1.5 eq.) to yield *m*-hydroxyphenyl-substituted alkyne **21l** (82%, 134 mg, 0.30 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3368, 2960, 2932, 2872, 1720, 1620, 1596, 1508, 1464, 1408, 1376, 1292, 1232, 1132, 1072, 1036, 992, 960 and 852; δ_H(400 MHz; $CDCl_3$) 8.79 (d, 1 H, *J* 4.6, H-2′), 8.25 (d, 1 H, *J* 9.2, H-8′), 8.16 (d, 1 H, *J* 1.6, H-13), 7.77 (dd, 1 H, *J* 5.7 and 3.3, H-15), 7.64 (d, 1 H, *J* 4.8, H-3′), 7.59 (dd, 1 H, *J* 5.8 and 3.4, H-17), 7.55–7.51 (dd, 1 H, *J* 9.2 and 2.6, H-7′), 7.26–7.18 (m, 2 H, H-5′, H-16), 6.52 (d, 1 H, *J* 6.4, H-9), 4.08 (s, 3 H, H-11′), 3.53–3.47 (m, 1 H, H-8), 3.34–3.27 (m, 1 H, H-2), 3.18–3.09 (m, 1 H, H-2), 2.92–2.74 (m, 2 H, H-6, H-6), 2.38–2.29 (m, 1 H, H-3), 2.24 (s, 3 H, H-19), 2.13–2.08 (m, 1 H, H-4), 1.76–1.68 (m, 3 H, H-7, H-7, H-5) and 1.53–1.46 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 169.79 (C, C-18), 166.90 (C, C-14), 157.22 (C, C-6′), 147.18 (CH, C-2′), 144.87 (C, C-10′), 143.91 (C, C-4′), 131.67 (CH, C-8′), 131.48 (CH, C-13), 131.39 (CH, C-15), 129.54 (C, C-12), 128.58 (CH, C-17), 126.93 (C, C-9′), 124.03 (CH, C-16), 121.38 (CH, C-7′), 117.85 (CH, C-3′), 101.66 (CH, C-5′), 95.62 (C, C-11), 81.32 (C, C-10), 73.02 (CH, C-9), 58.32 (CH, C-8), 55.19 (CH_3, C-11′), 49.77 (CH_2, C-2), 48.51 (CH_2, C-6), 29.74 (CH, C-3), 28.29 (CH, C-4), 25.72 (CH_2, C-7), 23.19 (CH_2, C-5) and 22.31 (CH_3, C-19); *m*/*z* (FAB) (EI) 457 (M^+ + H, 17%), 413 (15), 391 (36), 279 (7), 167 (19), 149 (100) and 113 (21).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(4-iodophenyl)-10,11-dide-hydro-6′-methoxycinchonan 21m. 10,11-Didehydroquinidine **9b** (546 mg, 1.50 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (53 mg, 0.08 mmol, 0.05 eq.), CuI (29 mg, 0.15 mmol, 0.1 eq.) and 1,4-diiodobenzene (743 mg, 2.25 mmol, 1.5 eq.) to yield *p*-iodophenyl-substituted alkyne **21m** (82%, 680 mg, 1.20 mmol); ν_{max}(CHCl$_3$)/cm^{-1} 2944, 2876, 2224, 1744, 1624, 1592, 1508, 1484, 1456, 1432, 1372, 1300, 1232, 1172, 1136, 1092, 1032, 1004, 844 and 824; δ_H(400 MHz; CDCl$_3$) 8.79 (d, 1 H, *J* 4.6, H-2′), 8.07 (d, 1 H, *J* 9.2, H-8′), 7.73 (d, 2 H, *J* 8.6, H-14, H-16), 7.52 (d, 1 H, *J* 2.6, H-5′), 7.43–7.38 (m, 2 H, H-3′, H-7′), 7.28 (d, 2 H, *J* 8.5, H-13, H-17), 6.73 (d, 1 H, *J* 7.3, H-9), 3.90 (s, 3 H, H-11′), 3.47–3.38 (m, 1 H, H-8), 3.22–3.07 (m, 2 H, H-2, H-2), 2.92–2.84 (m, 1 H, H-6), 2.80–2.71 (m, 2 H, H-6, H-3), 2.27–2.20 (m, 1 H, H-4), 2.15 (s, 3 H, H-20), 1.72–1.53 (m, 3 H, H-7, H-7, H-5) and 1.23–1.14 (m, 1 H, H-5); δ_C(100 MHz; CDCl$_3$) 169.89 (C, C-18), 157.91 (C, C-6′), 147.44 (CH, C-2′), 144.77 (C, C-4′), 143.54 (C, C-10′), 137.47 (CH, C-14, C-16), 133.23 (CH, C-13, C-17), 131.78 (CH, C-8′), 126.99 (C, C-9′), 123.23 (C, C-12), 121.89 (CH, C-7′), 118.82 (CH, C-3′), 101.36 (CH, C-5′), 94.37 (C, C-15), 93.48 (C, C-10), 80.92 (C, C-11), 73.52 (CH, C-9), 58.98 (CH, C-8), 55.49 (CH$_3$, C-11′), 50.41 (CH$_2$, C-2), 49.47 (CH$_2$, C-6), 28.98 (CH, C-3), 27.71 (CH, C-4), 25.10 (CH$_2$, C-5), 24.48 (CH$_2$, C-7) and 21.09 (CH$_3$, C-20); *m*/*z* (FAB) (EI) 567 (M$^+$ + H, 100%), 507 (6), 413 (17), 391 (29), 336 (15), 307 (7) and 279 (12).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(2-aminophenyl)-10,11-dide-hydro-6′-methoxycinchonan 21n. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-iodoaniline (117 mg, 0.53 mmol, 1.5 eq.) to yield 2-aminophenyl-substituted alkyne **21n** (92%, 150 mg, 0.33 mmol); ν_{max}(CHCl$_3$)/cm^{-1} 3452 2960, 2868, 2836, 2216, 1740, 1620, 1572, 1508, 1472, 1432, 1368, 1304, 1236, 1144, 1084, 1032, 904 and 844; δ_H(400 MHz; CDCl$_3$) 8.79 (d, 1 H, *J* 4.6, H-2′), 8.09 (d, 1 H, *J* 9.2, H-8′), 7.50 (d, 1 H, *J* 2.7, H-5′), 7.42 (d, 1 H, *J* 4.6, H-3′), 7.40 (dd, 1 H, *J* 9.2 and 2.6, H-7′), 7.19 (dd, 1 H, *J* 7.8 and 1.7, H-14), 7.14–7.09 (m, 1 H, H-15), 6.71–6.66 (m, 2 H, H-16, H-17), 6.54 (d, 1 H, *J* 7.5, H-9), 4.08 (s, 2 H, NH$_2$), 3.96 (s, 3 H, H-11′), 3.72–3.67 (m, 1 H, H-8), 3.28–3.21 (dd, 1 H, *J* 13.6 and 9.9, H-2$_{endo}$), 3.20–3.14 (m, 1 H, H-2), 2.97–2.89 (m, 1 H, H-6), 2.86–2.79 (m, 1 H, H-6), 2.74–2.66 (m, 1 H, H-3), 2.31–2.23 (m, 1 H, H-4), 2.18 (s, 3 H, H-19), 1.85–1.76 (m, 1 H, H-7), 1.67–1.53 (m, 2 H, H-7, H-5) and 1.48–1.42 (m, 1 H, H-5); δ_C(100 MHz; CDCl$_3$) 170.17 (C, C-18), 157.94 (C, C-6′), 147.58 (C, C-13), 147.45 (CH, C-2′), 144.75 (C, C-10′), 143.49 (C, C-4′), 132.14 (CH, C-14), 132.04 (CH, C-15), 131.77 (CH, C-8′), 129.13 (C, C-12), 127.04 (C, C-9′), 121.84 (CH, C-7′), 119.26 (CH, C-3′), 117.89 (CH, C-16), 114.24 (CH, C-17), 101.61 (CH, C-5′), 98.60 (C, C-11), 81.27 (C, C-10), 73.79 (CH, C-9), 58.66 (CH, C-8), 55.64 (CH$_3$, C-11′), 50.32 (CH$_2$, C-2), 48.91 (CH$_2$, C-6), 28.62 (CH, C-3), 27.15 (CH, C-4), 26.24 (CH$_2$, C-7), 25.10 (CH$_2$, C-5) and 21.10 (CH$_3$, C-19); *m*/*z* (MAT, 200 °C) (EI) 455.2199 (M$^+$, $C_{28}H_{29}N_3O_3$ requires 455.2209), 396 (11%), 369 (5), 355 (6), 325 (9), 313 (8), 296 (5), 278 (4), 258 (7), 231 (17), 225 (56), 211 (6), 197 (100), 182 (19), 168 (30), 155 (10), 143 (42), 130 (21), 115 (15), 91 (16) and 77 (11).

(3*S*,4*S*,8*R*,9*S*)-9-Acetoxy-3-benzofuryl-6′-methoxycinchonan 21o. 10,11-Didehydroquinidine **9b** (130 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-iodophenol (117 mg, 0.53 mmol, 1.5 eq.) to yield benzofuran **21o** (78%, 127 mg, 0.28 mmol); ν_{max}(CHCl$_3$)/cm^{-1} 3032, 2936, 2872, 2220, 1744, 1620, 1508, 1472, 1452, 1372, 1300, 1228, 1132, 1088, 1068, 1028, 988 and 844; δ_H(400 MHz; CDCl$_3$) 8.84 (d, 1 H, *J* 4.6, H-2′), 8.18 (d, 1 H, *J* 8.9, H-8′), 7.61 (d, 1 H, *J* 2.4, H-5′), 7.54–7.47 (m, 1 H, H-3′), 7.45–7.37 (m, 3 H, H-7′, H-13, H-16), 7.31–7.25 (m, 2 H, H-14, H-15), 6.77 (d, 1 H, *J* 7.2, H-9), 6.59 (s, 1 H, H-11), 3.96 (s, 3 H, H-11′), 3.44–3.37 (m, 1 H, H-8), 3.27–3.10 (m, 2 H, H-2, H-2), 2.98–2.84 (m, 2 H, H-6, H-6), 2.36–2.29 (m, 1 H, H-3), 2.24–2.20 (m, 1 H, H-4), 2.10 (s, 3 H, H-19), 2.07–1.98 (m, 1 H, H-7) and 1.78–1.52 (m, 3 H, H-7, H-5, H-5); δ_C(100 MHz; CDCl$_3$) 170.30 (C, C-18), 160.35 (C, C-17), 158.01 (C, C-6′), 147.63 (CH, C-2′), 144.83 (C, C-10), 144.09 (C, C-10′), 143.65 (C, C-4′), 131.75 (CH, C-8′), 129.85 (C, C-12), 128.57 (C, C-9′), 123.58 (CH, C-15), 122.69 (CH, C-14), 121.97 (CH, C-7′), 120.49 (CH, C-13), 120.24 (CH, C-3′), 110.87 (CH, C-16), 102.20 (CH, C-11), 101.53 (CH, C-5′), 73.45 (CH, C-9), 59.15 (CH, C-8), 55.62 (CH$_3$, C-11′), 49.89 (CH$_2$, C-2), 47.57 (CH$_2$, C-6), 29.27 (CH, C-3), 27.88 (CH, C-4), 26.12 (CH$_2$, C-7), 25.69 (CH$_2$, C-5) and 21.12 (CH$_3$, C-19); *m*/*z* (MAT, 200 °C) (EI) 456.2050 (M$^+$, $C_{28}H_{28}N_2O_4$ requires 456.2049), 441 (3%), 413 (3), 397 (9), 365 (4), 325 (5), 313 (2), 265 (2), 253 (6), 226 (100), 211 (7), 199 (22), 188 (51), 172 (22), 157 (29), 144 (82), 132 (23), 115 (6), 99 (7) and 86 (13).

(1*S*,2*S*,4*S*,5*S*)-2-Hydroxymethyl-5-phenylethynyl-1-aza-bicyclo[2.2.2]octane 23a. 10,11-Didehydroquincorine **18a** (600 mg, 3.64 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (128 mg, 0.18 mmol, 0.05 eq.), CuI (69 mg, 0.36 mmol, 0.1 eq.) and iodobenzene (0.61 ml, 5.46 mmol, 1.5 eq.) to yield phenyl-substituted alkyne **23a** (74%, 649 mg, 2.69 mmol); ν_{max}(CHCl$_3$)/cm^{-1} 3380, 3054, 2955, 2868, 2224, 1599, 1489, 1454, 1412, 1378, 1338, 1265, 1230, 1099, 1069, 1021, 995 and 942; δ_H(400 MHz; CDCl$_3$) 7.43–7.39 (m, 2 H, Ph-H), 7.32–7.27 (m, 3 H, Ph-H), 4.24 (s, 1 H, OH), 3.63–3.58 (m, 1 H, H-9), 3.54–3.47 (m, 1 H, H-9), 3.41–3.32 (m, 1 H, H-6), 3.20–3.07 (m, 2 H, H-2, H-6), 2.94–2.79 (m, 2 H, H-7, H-7), 2.28–2.19 (m, 1 H, H-5), 2.13–2.08 (m, 1 H, H-4), 1.71–1.55 (m, 3 H, H-3, H-8, H-8) and 1.04–0.97 (m, 1 H, H-3); δ_C(100 MHz; CDCl$_3$) 131.65 (CH, C-13, C-17), 128.28 (CH, C-14, C-16), 127.94 (CH, C-15), 123.34 (C, C-12), 91.99 (C, C-10), 81.71 (C, C-11), 62.18 (CH$_2$, C-9), 57.64 (CH, C-2), 56.60 (CH$_2$, C-6), 40.14 (CH$_2$, C-7), 28.23 (CH, C-5), 26.71 (CH, C-4), 25.51 (CH$_2$, C-8) and 24.54 (CH$_2$, C-3); *m*/*z* (MAT, 70 °C) (EI) 241.1468 (M$^+$, $C_{16}H_{19}N_1O_1$ requires 241.1467), 210 (100%), 128 (27) and 85 (32).

(1*S*,2*S*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-phenylethynyl-1-azabicyclo[2.2.2]octane 23b. 10,11-Didehydro-quincorine **18b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and iodobenzene (110 mg, 0.54 mmol, 1.5 eq.) to yield phenyl-substituted alkyne **23b** (84%, 107 mg, 0.30 mmol); ν_{max}(CHCl$_3$)/cm^{-1} 3056, 2952, 2928, 2884, 2856, 1596, 1468, 1388, 1360, 1324, 1264, 1228, 1172, 1116, 1080, 1028, 940 and 836; δ_H(400 MHz; CDCl$_3$) 7.42–7.39 (m, 2 H, Ph-H), 7.31–7.28 (m, 3 H, Ph-H), 3.84–3.80 (dd, 1 H, *J* 10.6 and 5.6, H-9), 3.78–3.73 (dd, *J* 10.5 and 5.8, H-9), 3.47–3.40 (dd, 1 H, *J* 12.9 and 10.4, H-6$_{endo}$), 3.24–3.17 (m, 1 H, H-2), 3.16–3.09 (m, 1 H, H-6$_{exo}$), 2.87–2.76 (m, 2 H, H-7, H-7), 2.25–2.17 (m, 1 H, H-5), 2.12–2.08 (m, 1 H, H-4), 1.70–1.62 (m, 1 H, H-3), 1.59–1.50 (m, 1 H, H-8), 1.45–1.38 (m, 1 H, H-8), 1.32–1.26 (m, 1 H, H-3), 0.93 (s, 9 H, SiC(*CH*$_3$)$_3$), 0.11 (s, 3 H, Si*CH*$_3$) and 0.10 (s, 3 H, Si*CH*$_3$); δ_C(100 MHz; CDCl$_3$) 131.96 (CH, C-13, C-17), 128.45 (CH, C-14, C-16), 127.75 (CH, C-15), 123.61 (C, C-12), 92.79 (C, C-10), 81.33 (C, C-11), 65.28 (CH$_2$, C-9), 57.51 (CH$_2$, C-6), 57.45 (CH, C-2), 42.29 (CH$_2$, C-7), 28.24 (CH, C-5), 27.20 (CH, C-4), 25.84 (CH$_3$, SiC(*C*H$_3$)$_3$), 25.72 (CH$_2$, C-8), 24.71 (CH$_2$, C-3), 18.39 (C, Si*C*(CH$_3$)$_3$), −5.23 (CH$_3$, Si*C*H$_3$) and −5.27 (CH$_3$, Si*C*H$_3$); *m*/*z* (MAT, 50 °C) (EI) 355.2333 (M$^+$, $C_{22}H_{33}N_1O_1Si$ requires 355.2331), 340 (8%), 299 (71), 280 (2), 270 (6), 240 (7), 222 (11), 210 (1000), 194 (3), 184 (40), 170 (10), 156 (26), 128 (15), 115 (11), 98 (6) and 75 (39.03).

(1*S*,2*S*,4*S*,5*S*)-2-Hydroxymethyl-5-(4-nitrophenylethynyl)-1-azabicyclo[2.2.2]octane 23c. 10,11-Didehydroquincorine **18a** (600 mg, 3.64 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (128 mg, 0.18 mmol, 0.05 eq.), CuI (69 mg, 0.36 mmol, 0.1 eq.) and *p*-nitrophenyl iodide (1358 mg, 5.46 mmol, 1.5 eq.) to yield *p*-nitrophenyl-substituted alkyne **23c** (77%, 801 mg, 2.80 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 3424, 2955, 2868, 2222, 1595, 1519, 1490, 1454, 1410, 1344, 1308, 1285, 1230, 1193, 1175, 1108, 1019, 996, 942 and 855; δ_H(400 MHz; $CDCl_3$) 8.17–8.13 (d, 2 H, *J* 8.9, H-14, H-16), 7.56–7.51 (d, 2 H, *J* 9.0, H-13, H-17), 4.17 (s, 1 H, OH), 3.62–3.57 (m, 1 H, H-9), 3.53–3.45 (m, 1 H, H-9), 3.37–3.29 (m, 1 H, H-6), 3.19–3.08 (m, 2 H, H-2, H-6), 2.96–2.90 (m, 1 H, H-7), 2.85–2.76 (m, 1 H, H-7), 2.22–2.15 (m, 1 H, H-5), 2.13–2.08 (m, 1 H, H-4), 1.66–1.58 (m, 2 H, H-3, H-8), 1.46–1.41 (m, 1 H, H-8) and 1.04–0.97 (m, 1 H, H-3); δ_C(100 MHz; $CDCl_3$) 146.84 (C, C-15), 132.45 (CH, C-13, C-17), 130.48 (C, C-12), 123.55 (CH, C-14, C-16), 98.29 (C, C-10), 80.15 (C, C-11), 62.28 (CH_2, C-9), 57.55 (CH, C-2), 56.37 (CH_2, C-6), 40.04 (CH_2, C-7), 28.52 (CH, C-5), 26.63 (CH, C-4), 25.62 (CH_2, C-8) and 24.69 (CH_2, C-3); *m*/*z* (MAT, 130 °C) (EI) 286.1317 (M^+, $C_{16}H_{18}N_2O_3$ requires 286.1317), 255 (100%), 228 (6), 209 (6), 181 (4), 152 (7), 126 (10), 102 (2), 87 (26) and 72 (12).

(1*S*,2*S*,4*S*,5*S*)-2-Hydroxymethyl-5-(4-ethoxycarbonylphenylethynyl)-1-azabicyclo[2.2.2]octane 23d. 10,11-Didehydroquincorine **18a** (600 mg, 3.64 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (128 mg, 0.18 mmol, 0.05 eq.), CuI (69 mg, 0.36 mmol, 0.1 eq.) and 4-ethoxycarbonylphenyl iodide (0.91 ml, 5.46 mmol, 1.5 eq.) to yield 4-ethoxycarbonylphenyl-substituted alkyne **23d** (71%, 808 mg, 2.58 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 3366, 2957, 2871, 2222, 1712, 1606, 1508, 1454, 1406, 1369, 1344, 1307, 1275, 1231, 1176, 1108, 1020, 996 and 858; δ_H(400 MHz; $CDCl_3$) 7.98–7.96 (d, 2 H, *J* 8.6, H-14, H-16), 7.47–7.45 (d, 2 H, *J* 8.5, H-13, H-17), 4.39 (q, 2 H, *J* 7.2, H-19), 4.35–4.28 (s, 1 H, OH), 3.68–3.53 (m, 2 H, H-9, H-9), 3.48–3.38 (m, 1 H, H-6), 3.27–3.13 (m, 2 H, H-2, H-6), 3.04–2.97 (m, 1 H, H-7), 2.96–2.86 (m, 1 H, H-7), 2.29–2.21 (m, 1 H, H-5), 2.17–2.12 (m, 1 H, H-4), 1.74–1.63 (m, 3 H, H-3, H-8, H-8), 1.41–1.37 (t, 3 H, *J* 7.2, H-20) and 1.11–1.04 (m, 1 H, H-3); δ_C(100 MHz; $CDCl_3$) 166.07 (C, C-18), 131.59 (CH, C-13, C-17), 129.73 (C, C-12), 129.43 (CH, C-14, C-16), 127.83 (C, C-15), 94.73 (C, C-10), 81.41 (C, C-11), 61.99 (CH_2, C-9), 61.13 (CH_2, C-19), 57.91 (CH, C-2), 56.23 (CH_2, C-6), 40.26 (CH_2, C-7), 28.19 (CH, C-5), 26.64 (CH, C-4), 25.33 (CH_2, C-8), 24.39 (CH_2, C-3) and 14.32 (CH_3, C-20); *m*/*z* (MAT, 110 °C) (EI) 313.1679 (M^+, $C_{19}H_{23}N_1O_3$ requires 313.1768), 283 (100%), 269 (7), 255 (6), 227 (2), 210 (2), 200 (6), 181 (2), 155 (4), 127 (3), 91 (1) and 72 (2).

(1*S*,2*S*,4*S*,5*S*)-2-Benzoyloxymethyl-5-(4-ethoxycarbonylphenylethynyl)-1-azabicyclo[2.2.2]octane 23e. 10,11-Didehydroquincorine **18c** (125 mg, 0.47 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (16 mg, 0.03 mmol, 0.05 eq.), CuI (9 mg, 0.05 mmol, 0.1 eq.) and ethyl 4-iodobenzoate (192 mg, 0.69 mmol, 1.5 eq.) to yield 4-ethoxycarbonylphenyl-substituted alkyne **23e** (92%, 172 mg, 0.43 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 3060, 2944, 2868, 2220, 1712, 1604, 1508, 1452, 1404, 1368, 1276, 1176, 1108, 1068, 1048, 1024, 976 and 856; δ_H(400 MHz; $CDCl_3$) 8.08–7.06 (d, 2 H, *J* 7.5, H-23, H-27), 7.99–7.96 (d, 2 H, *J* 8.2, H-14, H-16), 7.54–7.50 (m, 1 H, Ph-H), 7.48–7.45 (d, 2 H, *J* 8.2, H-13, H-17), 7.42–7.37 (m, 2 H, Ph-H), 4.53–4.46 (m, 1 H, H-9), 4.39 (q, 2 H, *J* 7.1, H-19), 4.35–4.28 (m, 1 H, H-9), 3.52–3.42 (m, 1 H, H-6), 3.21–3.07 (m, 2 H, H-2, H-6), 2.88–2.76 (m, 2 H, H-7, H-7), 2.33–2.27 (m, 1 H, H-5), 2.14–2.08 (m, 1 H, H-4), 1.70–1.51 (m, 3 H, H-3, H-8, H-8), 1.41–1.36 (t, 3 H, *J* 7.1, H-20) and 1.26–1.17 (m, 1 H, H-3); δ_C(100 MHz; $CDCl_3$) 166.68 (C, C-21), 166.08 (C, C-18), 132.95 (CH, C-25), 131.52 (CH, C-13, C-17), 130.06 (C, C-12), 129.75 (CH, C-23, C-27), 129.39 (CH, C-14, C-16), 128.56 (CH, C-24, C-26), 128.30 (C, C-22), 127.84 (C, C-15), 96.22 (C, C-10), 80.82 (C, C-11), 65.48 (CH_2, C-9), 61.07 (CH_2, C-19), 56.72 (CH_2, C-6), 54.44 (CH, C-2), 40.39 (CH_2, C-7), 28.37 (CH, C-5), 26.93 (CH, C-4), 26.00 (CH_2, C-8), 25.39 (CH_2, C-3) and 14.31 (CH_3, C-20); *m*/*z* (MAT, 120 °C) (EI) 417.1938 (M^+, $C_{16}H_{27}N_1O_4$ requires 417.1940), 367 (2%), 324 (4), 307 (2), 277 (100), 262 (2), 225 (4), 201 (19), 183 (15), 152 (9), 122 (15), 105 (26) and 77 (27).

(1*S*,2*S*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(3′-quinolylethynyl)-1-azabicyclo[2.2.2]octane 23f. 10,11-Didehydroquincorine **18b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 3-bromoquinoline (67 µl, 0.54 mmol, 1.5 eq.) to yield quinolyl-substituted alkyne **23f** (86%, 125 mg, 0.31 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 2940, 2928, 2856, 1596, 1468, 1388, 1344, 1320, 1256, 1188, 1116, 1084, 1028, 940 and 836; δ_H(400 MHz; $CDCl_3$) 8.86 (d, 1 H, *J* 2.2, H-2′), 8.17 (d, 1 H, *J* 2.1, H-4′), 8.08 (d, 1 H, *J* 8.4, H-8′), 7.76 (d, 1 H, *J* 8.0, H-5′), 7.71–7.66 (ddd, 1 H, *J* 8.3, 7.0 and 1.4, H-7′), 7.56–7.51 (ddd, 1 H, *J* 7.9, 7.2 and 1.1, H-6′), 3.70–3.66 (dd, 1 H, *J* 10.2 and 6.0, H-9), 3.64–3.59 (dd, *J* 10.3 and 6.0, H-9), 3.24–3.18 (dd, 1 H, *J* 13.3 and 10.1, H-6_{endo}), 3.11–2.89 (m, 3 H, H-2, H-6, H-7), 2.61–2.53 (m, 1 H, H-7), 2.34–2.30 (m, 1 H, H-5), 2.09–2.00 (m, 1 H, H-4), 1.96–1.92 (m, 1 H, H-3), 1.53–1.42 (m, 1 H, H-8), 1.32–1.21 (m, 2 H, H-8, H-3), 0.90 (s, 9 H, SiC(CH_3)$_3$) and 0.07 (s, 6 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 152.46 (CH, C-6′), 146.59 (C, C-10′), 138.01 (CH, C-2′), 129.67 (CH, C-8′), 129.36 (CH, C-7′), 127.39 (CH, C-5′), 127.34 (C, C-9′), 127.14 (CH, C-4′), 118.06 (C, C-3″), 97.43 (C, C-10), 81.49 (C, C-11), 65.92 (CH_2, C-9), 57.86 (CH_2, C-6), 57.13 (CH, C-2), 41.71 (CH_2, C-7), 29.28 (CH, C-5), 27.61 (CH, C-4), 26.01 (CH_3, SiC(CH_3)$_3$), 25.07 (CH_2, C-8), 22.68 (CH_2, C-3), 18.42 (C, SiC(CH_3)$_3$), −5.27 (CH_3, SiCH_3) and −5.34 (CH_3, SiCH_3); *m*/*z* (FAB) (EI) 407 (M^+ + H, 8%), 355 (14), 325 (10), 281 (41), 221 (55), 207 (43) and 147 (100).

(1*S*,2*S*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(2-aminophenylethynyl)-1-azabicyclo[2.2.2]octane 23g. 10,11-Didehydroquincorine **18b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-iodoaniline (118 mg, 0.54 mmol, 1.5 eq.) to yield *o*-aminophenyl-substituted alkyne **23g** (84%, 111 mg, 0.30 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 2940, 2928, 2856, 1612, 1492, 1456, 1388, 1360, 1304, 1256, 1228, 1116, 1084, 1028, 936, 836 and 808; δ_H(400 MHz; $CDCl_3$) 7.25 (dd, 1 H, *J* 7.5 and 1.5, H-17), 7.10–7.05 (ddd, 1 H, *J* 8.9, 7.6 and 1.5, H-14), 6.69–6.63 (m, 2 H, H-15, H-16), 4.23–4.10 (m, 2 H, NH_2), 3.73–3.63 (m, 2 H, H-9, H-9), 3.38–3.31 (dd, 1 H, *J* 13.2 and 10.0, H-6_{endo}), 3.12–2.98 (m, 2 H, H-2, H-6), 2.81–2.57 (m, 2 H, H-7, H-7), 2.47–2.42 (m, 1 H, H-5), 2.18–2.10 (m, 1 H, H-3), 2.07–2.02 (m, 1 H, H-4), 1.59–1.46 (m, 1 H, H-8), 1.32–1.24 (m, 2 H, H-8, H-3), 0.91 (s, 9 H, SiC(CH_3)$_3$) and 0.07 (s, 6 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 147.62 (C, C-13), 132.12 (CH, C-14), 128.96 (CH, C-15), 117.83 (CH, C-17), 114.18 (CH, C-16), 108.62 (C, C-12), 98.96 (C, C-10), 81.42 (C, C-11), 65.78 (CH_2, C-9), 57.52 (CH_2, C-6), 57.05 (CH, C-2), 41.84 (CH_2, C-7), 29.55 (CH, C-5), 27.46 (CH, C-4), 26.30 (CH_2, C-8), 26.00 (CH_3, SiC(CH_3)$_3$), 22.67 (CH_2, C-3), 18.39 (C, SiC(CH_3)$_3$), −5.30 (CH_3, SiCH_3) and −5.32 (CH_3, SiCH_3); *m*/*z* (FAB) (EI) 371 (M^+ + H, 16), 313 (11), 240 (9), 201 (8), 189 (15) and 147 (100).

(1*S*,2*S*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-benzofuryl-1-azabicyclo[2.2.2]octane 23h. 10,11-Didehydroquincorine **18b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-iodoaniline (119 mg, 0.54 mmol, 1.5 eq.) to yield benzofuran **23h** (78%, 104 mg,

0.28 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2940, 2928, 2856, 1612, 1460, 1388, 1344, 1324, 1256, 1188, 1116, 1084, 1028, 1004, 936, 836 and 808; δ_H(400 MHz; $CDCl_3$) 7.32–7.29 (dd, 1 H, *J* 7.7 and 1.6, H-13), 7.23–7.18 (ddd, *J* 8.7, 7.1 and 1.6, H-14), 6.86–6.82 (m, 1 H, H-15), 6.81–6.79 (dd, 1 H, *J* 8.6 and 1.6, H-16), 6.51 (m, 1 H, H-11), 3.73–3.61 (m, 2 H, H-9, H-9), 3.26–3.19 (dd, 1 H, *J* 13.4 and 10.0, H-6$_{endo}$), 3.13–2.91 (m, 2 H, H-2, H-6), 2.81–2.57 (m, 2 H, H-7, H-7), 2.37–2.32 (m, 1 H, H-5), 2.09–2.01 (m, 1 H, H-3), 1.99–1.95 (m, 1 H, H-4), 1.68–1.61 (m, 1 H, H-8), 1.53–1.43 (m, 2 H, H-8, H-3), 0.91 (s, 9 H, SiC(*CH*$_3$)$_3$) and 0.07 (s, 6 H, Si*CH*$_3$); δ_C(100 MHz; $CDCl_3$) 161.36 (C, C-17), 154.71 (C, C-10), 129.44 (CH, C-13), 128.65 (C, C-12), 122.50 (CH, C-14), 120.38 (CH, C-15), 110.78 (CH, C-16), 101.75 (CH, C-11), 65.80 (CH_2, C-9), 57.82 (CH_2, C-6), 56.99 (CH, C-2), 41.67 (CH_2, C-7), 35.77 (CH, C-5), 28.46 (CH, C-4), 27.07 (CH_2, C-8), 26.01 (CH_3, SiC(*C*H$_3$)$_3$), 25.01 (CH_2, C-3), 18.42 (C, Si*C*(CH$_3$)$_3$), −5.31 (CH_3, Si*C*H$_3$) and −5.33 (CH_3, Si*C*H$_3$); *m*/*z* (MAT) (EI) 372 (M^+ + H, 44%), 341 (13), 281 (43), 221 (47), 207 (41), 184 (16) and 147 (100).

(1*S*,2*R*,4*S*,5*S*)-2-Hydroxymethyl-5-(phenylethynyl)-1-azabicyclo[2.2.2]octane 24a. 10,11-Didehydroquincoridine **20a** (800 mg, 4.97 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (174 mg, 0.25 mmol, 0.05 eq.), CuI (92 mg, 0.50 mmol, 0.1 eq.) and phenyl iodide (1483 mg, 7.27 mmol, 1.5 eq.) to yield phenyl-substituted alkyne **24a** (65%, 759 mg, 3.15 mmol); ν_{max}($CHCl_3$)/cm^{-1} 3375, 3059, 2950, 2879, 2225, 1599, 1490, 1463, 1411, 1337, 1324, 1255, 1234, 1137, 1099, 1068, 1029, 1015 and 999; δ_H(400 MHz; $CDCl_3$) 7.42–7.39 (m, 2 H, Ph-H), 7.31–7.28 (m, 3 H, Ph-H), 4.62–4.45 (s, 1 H, OH), 3.83–3.63 (m, 2 H, H-9, H-9), 3.43–3.28 (m, 2 H, H-6, H-6), 3.26–3.07 (m, 3 H, H-2, H-7, H-7), 2.95–2.89 (m, 1 H, H-5), 2.14–2.10 (m, 1 H, H-4), 1.87–1.68 (m, 3 H, H-3, H-8, H-8) and 1.66–1.58 (m, 1 H, H-3); δ_C(100 MHz; $CDCl_3$) 131.67 (CH, C-15), 128.32 (CH, C-13, C-17), 128.07 (CH, C-14, C-16), 123.10 (C, C-12), 90.84 (C, C-10), 82.54 (C, C-11), 67.09 (CH_2, C-9), 58.15 (CH, C-2), 48.36 (CH_2, C-6), 47.91 (CH_2, C-7), 28.31 (CH, C-5), 27.18 (CH, C-4), 24.49 (CH_2, C-8) and 23.67 (CH_2, C-3); *m*/*z* (MAT, 60 °C) (EI) 241.1467 (M^+, $C_{16}H_{19}N_1O_1$ requires 241.1467), 224 (3%), 210 (100), 194 (2), 182 (12), 167 (5), 154 (7), 141 (6), 128 (46), 115 (11), 102 (3) and 84 (14).

(1*S*,2*R*,4*S*,5*S*)-2-Hydroxymethyl-5-(3′-quinolylethynyl)-1-azabicyclo[2.2.2]octane 24b. 10,11-Didehydroquincoridine **20a** (82 mg, 0.50 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (35 mg, 0.05 mmol, 0.1 eq.), CuI (19 mg, 0.10 mmol, 0.2 eq.) and 3-bromoquinoline (90 μl, 0.75 mmol, 1.5 eq.) to yield quinolyl-substituted alkyne **24b** (62%, 90 mg, 0.31 mmol) (Found: C, 77.72; H, 7.36; N, 9.40. $C_{19}H_{20}N_2O_1$ requires C, 78.05; H, 6.89; N, 9.58%); ν_{max}($CHCl_3$)/cm^{-1} 3416, 3068, 2948, 2876, 2200, 1600, 1568, 1488, 1412, 1372, 1336, 1256, 1228, 1136, 1100, 1064, 1028, 1012 and 908; δ_H(400 MHz; $CDCl_3$) 8.87 (d, 1 H, *J* 2.0, H-2′), 8.18 (d, 1 H, *J* 2.0, H-4′), 8.09 (d, 1 H, *J* 8.4, H-8′), 7.78 (d, 1 H, *J* 8.3, H-5′), 7.74–7.68 (ddd, 1 H, *J* 8.4, 7.0 and 1.5, H-7′), 7.58–7.53 (ddd, 1 H, *J* 8.2, 7.0 and 1.3, H-6′), 4.12–3.95 (s, 1 H, OH), 3.77–3.71 (dd, 1 H, *J* 11.4 and 10.4, H-9), 3.62–3.55 (dd, *J* 11.6 and 4.8, H-9), 3.17–3.05 (m, 3 H, H-6, H-6, H-2), 2.99–2.91 (m, 1 H, H-7), 2.86–2.80 (m, 1 H, H-7), 2.11–2.08 (m, 1 H, H-5), 1.76–1.70 (m, 1 H, H-4), 1.69–1.54 (m, 3 H, H-3, H-8, H-8) and 1.33–1.23 (m, 1 H, H-3); δ_C(100 MHz; $CDCl_3$) 152.31 (CH, C-2′), 146.60 (C, C-10′), 138.16 (CH, C-8′), 133.61 (C, C-9′), 129.83 (CH, C-4′), 129.29 (CH, C-7′), 127.43 (CH, C-6′), 127.22 (CH, C-5′), 117.67 (C, C-3′), 95.87 (C, C-10), 79.13 (CH, C-11), 62.10 (CH_2, C-9), 57.43 (CH, C-2), 48.38 (CH_2, C-6), 47.82 (CH_2, C-7), 29.13 (CH, C-5), 27.45 (CH, C-4), 25.38 (CH_2, C-8) and 23.34 (CH_2, C-3); *m*/*z* (MAT, 70 °C) (EI) 292.1576 (M^+, $C_{19}H_{20}N_2O_1$ requires 292.1576), 261 (6%), 237 (3), 224 (8), 207 (100), 175 (5), 166 (8), 149 (29), 128 (71), 105 (35), 101 (33), 86 (55) and 75 (78).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(4-ethoxycarbonylphenylethynyl)-1-azabicyclo[2.2.2]octane 24c. 10,11-Didehydroquincoridine **20b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and ethyl 4-iodobenzoate (148 mg, 0.54 mmol, 1.5 eq.) to yield 4-ethoxycarbonylphenyl-substituted alkyne **24c** (91%, 139 mg, 0.33 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2952, 2880, 2856, 2220, 1712, 1604, 1508, 1464, 1404, 1368, 1344, 1276, 1176, 1108, 1052, 1020, 940, 856 and 836; δ_H(400 MHz; $CDCl_3$) 7.97–7.95 (d, 2 H, *J* 8.4, H-14, H-16), 7.45–7.42 (d, 2 H, *J* 8.4, H-13, H-17), 4.40–4.34 (q, 2 H, *J* 7.1, H-19, H-19), 3.79–3.76 (m, 2 H, H-9, H-9), 3.19–3.13 (m, 2 H, H-6, H-6), 3.05–2.83 (m, 3 H, H-2, H-7, H-7), 2.78–2.73 (m, 1 H, H-5), 2.09–2.05 (m, 1 H, H-4), 1.89–1.83 (m, 1 H, H-3), 1.71–1.58 (m, 3 H, H-8, H-8, H-3), 1.41–1.37 (t, 3 H, *J* 7.1, H-20), 0.89 (s, 9 H, SiC(*CH*$_3$)$_3$), 0.08 (s, 3 H, SiC*H*$_3$) and 0.06 (s, 3 H, SiC*H*$_3$); δ_C(100 MHz; $CDCl_3$) 166.12 (C, C-18), 135.74 (C, C-15), 131.49 (CH, C-14, C-16), 129.35 (CH, C-14, C-16), 128.44 (C, C-12), 96.03 (C, C-10), 81.15 (C, C-11), 65.21 (CH_2, C-9), 61.05 (CH_2, C-19), 57.38 (CH, C-2), 49.69 (CH_2, C-6), 49.02 (CH_2, C-7), 29.08 (CH, C-5), 27.83 (CH, C-4), 26.00 (CH_3, SiC(*C*H$_3$)$_3$), 25.26 (CH_2, C-8), 25.09 (CH_2, C-3), 18.44 (C, Si*C*(CH$_3$)$_3$), 14.31 (CH_3, C-20), −5.23 (CH_3, Si*C*H$_3$) and −5.26 (CH_3, Si*C*H$_3$); *m*/*z* (FAB) (EI) 428 (M^+ + H, 100), 370 (45), 355 (14), 281 (22), 267 (10), 221 (35) and 147 (53).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(4-formylphenylethynyl)-1-azabicyclo[2.2.2]octane 24d. 10,11-Didehydroquincoridine **20b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 4-bromobenzaldehyde (100 mg, 0.54 mmol, 1.5 eq.) to yield *p*-formylphenyl-substituted alkyne **24d** (82%, 113 mg, 0.29 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2952, 2928, 2880, 2856, 2220, 1700, 1600, 1560, 1460, 1392, 1360, 1344, 1320, 1256, 1164, 1116, 1100, 1008 and 836; δ_H(400 MHz; $CDCl_3$) 10.01 (s, 1 H, H-18), 7.84–7.81 (d, 2 H, *J* 8.5, H-14, H-16), 7.56–7.53 (d, 2 H, *J* 8.2, H-13, H-17), 3.91–3.76 (m, 2 H, H-9, H-9), 3.31–3.28 (d, 1 H, *J* 13.2, H-6$_{endo}$), 3.18–3.15 (d, 1 H, *J* 13.1, H-6$_{exo}$), 3.12–3.03 (m, 1 H, H-2), 2.99–2.82 (m, 2 H, H-7, H-7), 2.66–2.61 (m, 1 H, H-5), 2.17–2.13 (m, 1 H, H-4), 2.08–1.97 (m, 1 H, H-3), 1.78–1.57 (m, 3 H, H-8, H-8, H-3), 0.89 (s, 9 H, SiC(*CH*$_3$)$_3$), 0.09 (s, 3 H, Si*CH*$_3$) and 0.07 (s, 3 H, Si*CH*$_3$); δ_C(100 MHz; $CDCl_3$) 191.41 (C, C-18), 135.20 (C, C-15), 132.19 (CH, C-14, C-16), 129.96 (C, C-12), 129.49 (CH, C-14, C-16), 96.82 (C, C-10), 81.34 (C, C-11), 64.59 (CH_2, C-9), 57.20 (CH, C-2), 49.09 (CH_2, C-6), 48.49 (CH_2, C-7), 28.65 (CH, C-5), 27.79 (CH, C-4), 25.97 (CH_3, SiC(*C*H$_3$)$_3$), 25.94 (CH_2, C-8), 24.79 (CH_2, C-3), 18.39 (C, Si*C*(CH$_3$)$_3$), −5.33 (CH_3, Si*C*H$_3$) and −5.36 (CH_3, Si*C*H$_3$); *m*/*z* (MAT, 80 °C) (EI) 383.2279 (M^+, $C_{23}H_{33}N_1O_2Si$ requires 383.2281), 326 (3%), 280 (4), 264 (4), 238 (3), 222 (41), 202 (14), 184 (45), 156 (100), 135 (6), 110 (4), 83 (28) and 75 (64).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(3-hydroxyphenylethynyl)-1-azabicyclo[2.2.2]octane 24e. 10,11-Didehydroquincoridine **20b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 3-iodophenol (119 mg, 0.54 mmol, 1.5 eq.) to yield *m*-hydroxyphenyl-substituted alkyne **24e** (89%, 118 mg, 0.32 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2952, 2932, 2880, 2856, 2220, 1592, 1452, 1388, 1360, 1344, 1288, 1256, 1156, 1116, 1096, 1052, 1024 and 836; δ_H(400 MHz; $CDCl_3$) 7.14–7.09 (m, 1 H, H-16), 6.89 (m, 1 H, H-15), 6.82 (s, 1 H, H-13), 6.76 (m, 1 H, H-17), 3.88–3.83 (dd, 1 H, *J* 10.5 and 6.9, H-9), 3.77–3.72 (dd,

1 H, *J* 10.5 and 6.0, H-9), 3.26–3.18 (m, 2 H, H-6, H-6), 3.08–2.99 (m, 2 H, H-2, H-7), 2.96–2.86 (m, 1 H, H-7), 2.82–2.76 (m, 1 H, H-5), 2.12–2.08 (m, 1 H, H-4), 1.88–1.80 (m, 1 H, H-3), 1.77–1.60 (m, 3 H, H-8, H-8, H-3), 0.87 (s, 9 H, SiC(CH_3)$_3$), 0.05 (s, 3 H, SiCH_3) and 0.02 (s, 3 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 157.00 (C, C-14), 129.30 (CH, C-15), 124.28 (C, C-12), 122.79 (CH, C-13), 118.99 (CH, C-16), 116.02 (CH, C-17), 91.27 (C, C-10), 82.12 (C, C-11), 64.31 (CH_2, C-9), 57.66 (CH, C-2), 49.44 (CH_2, C-6), 48.49 (CH_2, C-7), 28.80 (CH, C-5), 27.62 (CH, C-4), 26.05 (CH_3, SiC(CH_3)$_3$), 25.02 (CH_2, C-8), 24.78 (CH_2, C-3), 18.44 (C, SiC(CH_3)$_3$), −5.29 (CH_3, SiCH_3) and −5.34 (CH_3, SiCH_3); *m*/*z* (MAT, 80 °C) (EI) 371 (M^+, 6%), 356 (4), 328 (3), 314 (100), 301 (7), 290 (43), 278 (5), 226 (1), 129 (2), 115 (1) and 86 (3).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(1,3-thiazolin-2-ylethynyl)-1-azabicyclo[2.2.2]octane 24f. 10,11-Didehydroquincoridine **20b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-bromothiazole (48 μl, 0.54 mmol, 1.5 eq.) to yield thiazolinyl-substituted alkyne **24f** (83%, 108 mg, 0.30 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2952, 2928, 2880, 2856, 2220, 1480, 1472, 1408, 1360, 1344, 1320, 1264, 1136, 1116, 1096, 1056, 1020, 936 and 836; δ_H(400 MHz; $CDCl_3$) 7.78 (d, 1 H, *J* 3.3, H-14), 7.30 (d, 1 H, *J* 3.4, H-15), 3.79–3.70 (m, 2 H, H-9, H-9), 3.18–3.15 (m, 2 H, H-6, H-6), 3.05–2.96 (m, 1 H, H-2), 2.94–2.82 (m, 2 H, H-7, H-7), 2.80–2.75 (m, 1 H, H-5), 2.13–2.09 (m, 1 H, H-4), 1.84–1.77 (m, 1 H, H-3), 1.70–1.56 (m, 3 H, H-8, H-8, H-3), 0.89 (s, 9 H, SiC(CH_3)$_3$), 0.08 (s, 3 H, SiCH_3) and 0.06 (s, 3 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 149.18 (C, C-12), 143.14 (CH, C-14), 119.96 (CH, C-15), 98.39 (C, C-10), 79.91 (C, C-11), 65.13 (CH_2, C-9), 57.37 (CH, C-2), 49.00 (CH_2, C-6), 48.92 (CH_2, C-7), 29.19 (CH, C-5), 27.58 (CH, C-4), 26.04 (CH_3, SiC(CH_3)$_3$), 25.71 (CH_2, C-8), 25.16 (CH_2, C-3), 18.44 (C, SiC(CH_3)$_3$), −5.24 (CH_3, SiCH_3) and −5.27 (CH_3, SiCH_3); *m*/*z* (MAT, 50 °C) (EI) 362.1848 (M^+, $C_{19}H_{30}N_2O_1S_1Si$ requires 362.1848), 348 (3%), 321 (1), 305 (33), 280 (10), 264 (9), 240 (11), 222 (100), 195 (2), 184 (8), 156 (12), 134 (16), 110 (10), 91 (7), 82 (7) and 75 (42).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(2-thienylethynyl)-1-azabicyclo[2.2.2]octane 24g. 10,11-Didehydroquincoridine **20b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and 2-bromothiophene (52 μl, 0.54 mmol, 1.5 eq.) to yield thiophenyl-substituted alkyne **24g** (80%, 104 mg, 0.29 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2948, 2928, 2880, 2856, 2220, 1468, 1388, 1360, 1340, 1320, 1256, 1116, 1080, 1052, 1020, 936 and 908; δ_H(400 MHz; $CDCl_3$) 7.21 (dd, 1 H, *J* 5.2 and 1.2, H-15), 7.14 (dd, 1 H, *J* 3.6 and 1.0, H-13), 6.97 (dd, 1 H, *J* 5.2 and 3.6, H-14), 3.82–3.67 (m, 2 H, H-9, H-9), 3.15–3.09 (m, 1 H, H-6), 3.06–3.01 (m, 1 H, H-6), 2.98–2.72 (m, 3 H, H-2, H-7, H-7), 2.58–2.54 (m, 1 H, H-5), 1.99–1.95 (m, 1 H, H-4), 1.82–1.72 (m, 1 H, H-3), 1.69–1.49 (m, 3 H, H-8, H-8, H-3), 0.93 (s, 9 H, SiC(CH_3)$_3$), 0.10 (s, 3 H, SiCH_3) and 0.09 (s, 3 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 131.13 (CH, C-15), 126.76 (CH, C-14), 126.06 (CH, C-13), 123.96 (C, C-12), 96.86 (C, C-10), 80.73 (C, C-11), 65.37 (CH_2, C-9), 57.37 (CH, C-2), 49.33 (CH_2, C-6), 48.96 (CH_2, C-7), 29.08 (CH, C-5), 27.81 (CH, C-4), 26.07 (CH_3, SiC(CH_3)$_3$), 25.69 (CH_2, C-8), 25.16 (CH_2, C-3), 18.47 (C, SiC(CH_3)$_3$), −5.21 (CH_3, SiCH_3) and −5.23 (CH_3, SiCH_3); *m*/*z* (MAT, 80 °C) (EI) 361.1885 (M^+, $C_{20}H_{31}N_1O_1S_1Si$ requires 361.1895), 346 (8%), 318 (3), 304 (100), 276 (2), 264 (4), 240 (9), 216 (58), 203 (3), 184 (9), 156 (16), 134 (21), 115 (91), 94 (9), 85 (49) and 73 (36).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(2-(*E*)-chlorovinylethynyl)-1-azabicyclo[2.2.2]octane 24h. 10,11-Didehydroquincoridine **20b** (100 mg, 0.36 mmol, 1 eq.) was allowed to react with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and (*E*)-1,2-dichloroethene (27 μl, 0.36 mmol, 1 eq.) in Pr^i_2NH–THF (3:1) to yield (*E*)-chlorovinyl-substituted alkyne **24h** (78%, 95 mg, 0.28 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2936, 2880, 2856, 2210, 1468, 1380, 1360, 1320, 1256, 1228, 1176, 1116, 1092, 1052, 1024, 1004, 936, 916 and 836; δ_H(400 MHz; $CDCl_3$) 6.45 (dd, 1 H, *J* 13.6 and 0.8, H-13), 5.94 (dd, 1 H, *J* 13.6 and 2.2, H-12), 3.74–3.70 (dd, 1 H, *J* 10.2 and 6.0, H-9), 3.69–3.64 (dd, 1 H, *J* 10.3 and 6.8, H-9), 3.08–2.80 (m, 2 H, H-6, H-6), 2.69–2.65 (m, 1 H, H-2), 2.61–2.51 (m, 2 H, H-7, H-7), 2.43–2.37 (m, 1 H, H-5), 1.94–1.90 (m, 1 H, H-4), 1.74–1.68 (m, 1 H, H-3), 1.63–1.50 (m, 3 H, H-8, H-8, H-3), 0.91 (s, 9 H, SiC(CH_3)$_3$), 0.08 (s, 3 H, SiCH_3) and 0.07 (s, 3 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 129.02 (CH, C-13), 114.13 (CH, C-12), 95.96 (C, C-10), 77.39 (C, C-11), 65.34 (CH_2, C-9), 57.23 (CH, C-2), 49.63 (CH_2, C-6), 48.99 (CH_2, C-7), 29.12 (CH, C-5), 27.75 (CH, C-4), 25.99 (CH_3, SiC(CH_3)$_3$), 25.08 (CH_2, C-8), 24.25 (CH_2, C-3), 18.45 (C, SiC(CH_3)$_3$), −5.25 (CH_3, SiCH_3) and −5.29 (CH_3, SiCH_3); *m*/*z* (MAT) (EI) 339.1786 (M^+, $C_{18}H_{30}N_1O_1SiCl$ requires 339.1785), 324 (9%), 304 (11), 282 (100), 269 (1), 240 (18), 222 (4), 194 (22), 170 (8), 132 (7), 115 (8), 98 (32) and 73 (31).

(1*S*,2*R*,4*S*,5*S*)-2-*tert*-Butyldimethylsilanyloxymethyl-5-(2-(*Z*)-chlorovinylethynyl)-1-azabicyclo[2.2.2]octane 24i. 10,11-Didehydroquincoridine **20b** (165 mg, 0.59 mmol, 1 eq.) was allowed to react with $(Ph_3P)_2PdCl_2$ (21 mg, 0.03 mmol, 0.05 eq.), CuI (11 mg, 0.06 mmol, 0.1 eq.) and (*Z*)-1,2-dichloroethene (86 mg, 0.89 mmol, 1.5 eq.) in piperidine–THF (3:1) to yield (*Z*)-chlorovinyl-substituted alkyne **24i** (83%, 166 mg, 0.49 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2948, 2880, 2856, 2208, 1464, 1388, 1360, 1324, 1256, 1116, 1084, 1052, 1020, 936, 912 and 836; δ_H(400 MHz; $CDCl_3$) 6.33 (dd, 1 H, *J* 7.4 and 0.5, H-13), 5.94 (dd, 1 H, *J* 7.4 and 2.2, H-12), 3.77–3.72 (dd, 1 H, *J* 10.2 and 6.2, H-9), 3.68–3.63 (dd, 1 H, *J* 10.3 and 7.1, H-9), 3.12–2.96 (m, 2 H, H-6, H-6), 2.94–2.76 (m, 3 H, H-2, H-7, H-7), 2.68–2.63 (m, 1 H, H-5), 2.00–1.96 (m, 1 H, H-4), 1.79–1.72 (m, 1 H, H-3), 1.63–1.49 (m, 3 H, H-8, H-8, H-3), 0.90 (s, 9 H, SiC(CH_3)$_3$), 0.08 (s, 3 H, SiCH_3) and 0.07 (s, 3 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 127.25 (CH, C-13), 112.31 (CH, C-12), 96.05 (C, C-10), 75.84 (C, C-11), 65.42 (CH_2, C-9), 57.30 (CH, C-2), 49.77 (CH_2, C-6), 48.96 (CH_2, C-7), 29.19 (CH, C-5), 27.82 (CH, C-4), 25.98 (CH_3, SiC(CH_3)$_3$), 25.02 (CH_2, C-8), 24.36 (CH_2, C-3), 18.39 (C, SiC(CH_3)$_3$), −5.31 (CH_3, SiCH_3) and −5.34 (CH_3, SiCH_3); *m*/*z* (MAT) (EI) 339.1784 (M^+, $C_{18}H_{30}NOSiCl$ requires 339.1785), 324 (9%), 304 (11), 282 (100), 261 (1), 249 (1), 240 (20), 194 (22), 170 (7), 131 (7), 116 (8), 98 (14) and 73 (30).

(3*R*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(*Z*)-phenylethynyl-6′-methoxycinchonan 25a. (*Z*)-11-(2-Iodovinyl)quinidine **11b** (92 mg, 0.19 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.1 eq.), CuI (7 mg, 0.04 mmol, 0.2 eq.) and phenylacetylene (19 mg, 0.19 mmol, 1 eq.) to yield (*Z*)-enyne **25a** (86%, 74 mg, 0.16 mmol); ν_{max}($CHCl_3$)/cm^{-1} 2940, 2876, 1744, 1664, 1620, 1592, 1508, 1472, 1456, 1372, 1356, 1304, 1236, 1176, 1120, 1084, 1068, 1028, 988 and 844; δ_H(400 MHz; $CDCl_3$) 8.81 (d, 1 H, *J* 4.6, H-2′), 8.12 (d, 1 H, *J* 9.2, H-8′), 7.74 (dd, 1 H, *J* 9.2 and 2.4, H-7′), 7.61 (m, 2 H, H-3′, H-5′), 7.54–7.43 (m, 2 H, Ph-H), 7.37–7.33 (m, 3 H, Ph-H), 6.64 (d, 1 H, *J* 6.8, H-9), 6.61–6.57 (dd, 1 H, *J* 9.7 and 8.6, H-10), 6.40–6.38 (d, 1 H, *J* 10.1, H-11), 3.99 (s, 3 H, H-11′), 3.78–3.69 (m, 1 H, H-8), 3.44–3.34 (m, 1 H, H-2), 3.24–3.12 (m, 1 H, H-2), 3.08–2.96 (m, 2 H, H-6, H-6), 2.89–2.85 (m, 1 H, H-3), 2.21 (s, 3 H, H-21), 2.01–1.88 (m, 2 H, H-4, H-7) and 1.74–1.57 (m, 3 H, H-7, H-5, H-5); δ_C(100 MHz; $CDCl_3$) 169.99 (C, C-20), 158.03 (C, C-6′), 145.99 (CH, C-2′), 144.02 (C, C-10′), 143.62 (C, C-4′), 132.14 (CH, C-15, C-19), 131.94 (CH, C-8′), 131.38 (CH, C-17), 129.21 (CH, C-10),

128.56 (CH, C-16, C-18), 128.24 (C, C-9′), 123.33 (C, C-14), 121.83 (CH, C-7′), 118.05 (CH, C-3′), 110.07 (CH, C-11), 101.59 (CH, C-5′), 93.96 (C, C-13), 86.26 (C, C-12), 73.58 (CH, C-9), 58.44 (CH, C-8), 55.68 (CH_3, C-11′), 49.70 (CH_2, C-2), 47.23 (CH_2, C-6), 29.69 (CH, C-3), 27.90 (CH, C-4), 26.24 (CH_2, C-7), 25.31 (CH_2, C-5) and 21.17 (CH_3, C-21); *m*/*z* (FAB) (EI) 467 (M^+ + H, 28%), 429 (7), 401 (10), 355 (26), 341 (20), 325 (13), 295 (16), 281 (52), 221 (78), 207 (51) and 147 (100).

(3*R*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(*Z*)-hept-1-ynyl-6′-methoxycinchonan 25b. (*Z*)-11-(2-Iodovinyl)quinidine **11b** (110 mg, 0.22 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (8 mg, 0.01 mmol, 0.05 eq.), CuI (4 mg, 0.02 mmol, 0.1 eq.) and hept-1-yne (38 μl, 0.29 mmol, 1.3 eq.) to yield (*Z*)-enyne **25b** (82%, 84 mg, 0.18 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2936, 2872, 1744, 1664, 1620, 1592, 1508, 1472, 1456, 1432, 1372, 1304, 1236, 1172, 1112, 1084, 1068, 1032, 988 and 844; δ_H(400 MHz; $CDCl_3$) 8.84 (d, 1 H, *J* 4.4, H-2′), 8.16 (d, 1 H, *J* 9.2, H-8′), 7.43–7.37 (m, 3 H, H-7′, H-3′, H-5′), 6.61 (d, 1 H, *J* 6.8, H-9), 6.17–6.13 (dd, 1 H, *J* 10.7 and 8.1, H-10), 5.61–5.57 (d, 1 H, *J* 10.8, H-11), 3.98 (s, 3 H, H-11′), 3.77–3.68 (m, 1 H, H-8), 3.39–3.29 (m, 1 H, H-2$_{endo}$), 3.13–3.05 (dd, 1 H, *J* 15.6 and 12.7, H-2$_{exo}$), 2.94–2.78 (m, 2 H, H-6, H-6), 2.38–2.34 (m, 1 H, H-3), 2.18 (s, 3 H, H-20), 1.92–1.85 (m, 3 H, H-4, H-14, H-14), 1.64–1.53 (m, 4 H, 2 H-7, 2 H-15), 1.45–1.28 (m, 6 H, 2 H-5, 2 H-16, 2 H-17) and 0.98–0.90 (t, 3 H, *J* 7.1, H-18); δ_C(100 MHz; $CDCl_3$) 169.99 (C, C-19), 158.01 (C, C-6′), 147.67 (CH, C-2′), 144.09 (C, C-10′), 143.94 (C, C-4′), 131.77 (CH, C-8′), 128.75 (CH, C-10), 128.46 (C, C-9′), 121.96 (CH, C-7′), 118.55 (CH, C-3′), 110.48 (CH, C-11), 101.41 (CH, C-5′), 95.15 (C, C-13), 84.59 (C, C-12), 73.50 (CH, C-9), 58.85 (CH, C-8), 55.67 (CH_3, C-11′), 49.88 (CH_2, C-2), 49.74 (CH_2, C-6), 36.68 (CH, C-3), 31.07 (CH_2, C-16), 28.45 (CH_2, C-15), 27.72 (CH, C-4), 26.17 (CH_2, C-7), 23.62 (CH_2, C-5), 22.19 (CH_2, C-17), 21.16 (CH_3, C-20), 19.50 (CH_2, C-14) and 14.01 (CH_3, C-18); *m*/*z* (FAB) (EI) 461 (M^+ + H, 100%), 401 (29), 282 (21), 230 (83), 207 (30), 189 (35) and 147 (72).

(3*R*,4*S*,8*R*,9*S*)-9-Acetoxy-11-(*Z*)-(5-hydroxypent-1-ynyl)-6′-methoxycinchonan 25c. (*Z*)-11-(2-Iodovinyl)quinidine **11b** (110 mg, 0.22 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (8 mg, 0.01 mmol, 0.05 eq.), CuI (4 mg, 0.02 mmol, 0.1 eq.) and pent-4-yn-1-ol (20 μl, 0.22 mmol, 1 eq.) to yield (*Z*)-enyne **25c** (78%, 78 mg, 0.17 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3624, 2940, 2876, 2212, 1744, 1664, 1620, 1592, 1508, 1472, 1456, 1432, 1372, 1228, 1172, 1136, 1032, 988 and 844; δ_H(400 MHz; $CDCl_3$) 8.75 (d, 1 H, *J* 4.6, H-2′), 8.06 (d, 1 H, *J* 9.0, H-8′), 7.42–7.40 (m, 1 H, H-7′), 7.39 (d, 1 H, *J* 2.7, H-5′), 7.38 (d, 1 H, *J* 4.6, H-3′), 6.59 (d, 1 H, *J* 6.4, H-9), 6.18–6.13 (dd, 1 H, *J* 10.6 and 8.4, H-10), 5.59–5.56 (d, 1 H, *J* 10.5, H-11), 3.99 (s, 3 H, H-11′), 3.79–3.71 (m, 2 H, H-16, H-16), 3.35–3.28 (m, 1 H, H-8), 3.11–3.04 (dd, 1 H, *J* 12.7 and 9.7, H-2$_{endo}$), 2.92–2.78 (m, 3 H, H-2$_{exo}$, H-6, H-6), 2.55–2.39 (m, 3 H, H-3, H-14, H-14), 2.18 (s, 3 H, H-18), 1.92–1.85 (m, 1 H, H-4), 1.84–1.76 (m, 2 H, H-15, H-15), 1.67–1.49 (m, 3 H, H-7, H-7, H-5) and 1.38–1.30 (m, 1 H, H-5); δ_C(100 MHz; $CDCl_3$) 169.98 (C, C-17), 158.04 (C, C-6′), 147.27 (CH, C-2′), 144.55 (C, C-10′), 144.41 (CH, C-10), 143.76 (C, C-4′), 131.61 (CH, C-8′), 126.94 (C, C-9′), 122.01 (CH, C-7′), 118.46 (CH, C-3′), 110.31 (CH, C-11), 101.39 (CH, C-5′), 94.28 (C, C-13), 84.11 (C, C-12), 73.57 (CH, C-9), 61.37 (CH_2, C-16), 58.76 (CH, C-8), 55.71 (CH_3, C-11′), 49.79 (CH_2, C-2), 49.64 (CH_2, C-6), 36.67 (CH, C-3), 31.54 (CH_2, C-15), 27.72 (CH, C-4), 26.09 (CH_2, C-7), 23.74 (CH_2, C-5), 21.16 (CH_3, C-18) and 16.15 (CH_2, C-14); *m*/*z* (FAB) (EI) 449 (M^+ + H, 73%), 413 (12), 391 (23), 279 (8), 167 (19) and 149 (100).

(3*R*,4*S*,8*S*,9*R*)-9-Acetoxy-11-(*Z*)-hept-1-ynyl-6′-methoxycinchonan 26. (*Z*)-11-(2-Iodovinyl)quinine **12** (100 mg, 0.20 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (7 mg, 0.01 mmol, 0.05 eq.), CuI (4 mg, 0.02 mmol, 0.1 eq.) and hept-1-yne (37 μl, 0.28 mmol, 1.4 eq.) to yield (*Z*)-enyne **26** (86%, 81 mg, 0.17 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2936, 2869, 1743, 1622, 1593, 1510, 1474, 1434, 1372, 1265, 1238, 1086, 1031 and 850; δ_H(400 MHz; $CDCl_3$) 8.75 (d, 1 H, *J* 4.4, H-2′), 8.03 (d, 1 H, *J* 9.2, H-8′), 7.44 (d, 1 H, *J* 2.8, H-5′), 7.37 (dd, 1 H, *J* 9.3 and 2.6, H-7′), 7.36 (d, 1 H, *J* 4.6, H-3′), 6.53 (d, 1 H, *J* 6.9, H-9), 5.85 (dd, 1 H, *J* 10.5 and 9.3, H-10), 5.44 (dd, 1 H, *J* 10.5 and 1.0, H-11), 3.97 (s, 3 H, H-11′), 3.38 (ddd, 1 H, *J* 8.8, 7.7 and 7.6, H-8), 3.17 (dd, 1 H, *J* 13.7 and 10.0, H-2$_{exo}$), 3.16–3.08 (m, 1 H, H-6$_{endo}$), 2.91–2.83 (m, 1 H, H-2$_{endo}$), 2.74–2.66 (m, 1 H, H-6$_{exo}$), 2.57–2.50 (m, 1 H, H-3), 2.31 (m, 2 H, H-14, H-14), 2.13 (s, 3 H, H-20), 1.92 (m, 1 H, H-4), 1.89–1.81 (m, 1 H, H-7), 1.77–1.68 (m, 1 H, H-7), 1.65–1.49 (m, 4 H, 2 H-5, 2 H-15), 1.41–1.27 (m, 4 H, 2 H-16, 2 H-17) and 0.90 (t, 3 H, *J* 7.2, H-18); δ_C(100 MHz; $CDCl_3$) 170.00 (C, C-19), 157.99 (C, C-6′), 147.47 (CH, C-2′), 145.24 (C, C-10′), 144.76 (C, C-4′), 131.92 (CH, C-8′), 130.95 (CH, C-10), 127.04 (C, C-9′), 121.83 (CH, C-7′), 118.78 (CH, C-3′), 110.18 (CH, C-11), 101.47 (CH, C-5′), 95.28 (C, C-13), 77.19 (C, C-12), 73.64 (CH, C-9), 59.29 (CH, C-8), 57.70 (CH_2, C-2), 55.71 (CH_3, C-11′), 42.38 (CH_2, C-6), 36.66 (CH, C-3), 31.05 (CH_2, C-16), 28.44 (CH_2, C-15), 27.52 (CH_2, C-5), 27.05 (CH, C-4), 24.48 (CH_2, C-7), 22.20 (CH_2, C-17), 21.10 (CH_3, C-20), 19.49 (CH_2, C-14) and 14.02 (CH_3, C-18); *m*/*z* (MAT, 140 °C) (EI) 460.2726 (M^+ + H, $C_{29}H_{36}N_2O_3$ requires 460.2725), 412 (4%), 367 (5), 308 (37), 294 (3), 277 (100), 230 (29), 201 (19), 183 (14), 152 (8) and 91 (35).

(1*S*,2*S*,4*S*)-2-(Hydroxymethyl)-5-phenylethynyl-1-azabicyclo-[2.2.2]oct-5-ene 27. Vinyltin precursor **15** (152 mg, 0.36 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (13 mg, 0.02 mmol, 0.05 eq.), CuI (7 mg, 0.04 mmol, 0.1 eq.) and phenylacetylene (55 mg, 0.54 mmol, 1.5 eq.) to yield enyne **27** (69%, 59 mg, 0.25 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3590, 2999, 2954, 2876, 2220, 1599, 1447, 1409, 1330, 1260, 1138, 1067 and 1024; δ_H(400 MHz; $CDCl_3$; CD_3OD) 7.41–7.37 (m, 2 H, Ar-H), 7.36–7.31 (m, 3 H, Ar-H), 6.68 (s, 1 H, H-6), 3.89–3.82 (m, 1 H, H-9), 3.76–3.69 (m, 1 H, H-9), 3.64–3.56 (m, 1 H, H-7), 3.30–3.04 (m, 2 H, H-7, H-2), 2.39–2.24 (m, 2 H, H-4, H-3), 2.01–1.89 (m, 1 H, H-8) and 1.73–1.64 (m, 2 H, H-8, H-3); δ_C(100 MHz; $CDCl_3$, CD_3OD) 131.54 (CH, Ph), 131.17 (C, C-5), 128.96 (CH, C-6), 128.74 (CH, Ph), 121.82 (C, Ph), 90.05 (C, C-10), 83.97 (C, C-11), 62.14 (CH_2, C-9), 58.41 (CH, C-2), 43.85 (CH_2, C-7), 34.07 (CH, C-4), 21.39 (CH_2, C-8) and 20.54 (CH_2, C-3); *m*/*z* (MAT, 180 °C) (EI) 239.1308 (M^+, $C_{16}H_{17}N_1O_1$ requires 239.1310), 226 (100%), 208 (21), 198 (33), 180 (30), 171 (17), 155 (52), 140 (17), 127 (22), 113 (23) and 96 (36).

(3*S*,3″*S*,4*S*,4″*S*,8*R*,8″*R*,9*S*,9″*S*)-11,11″-Bi(10,11-didehydro-9-hydroxy-6′-methoxycinchonan) 28a. 10,11-Didehydroquinidine **9a** (161 mg, 0.50 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (18 mg, 0.025 mmol, 0.05 eq.), CuI (10 mg, 0.05 mmol, 0.1 eq.) and iodine (64 mg, 0.25 mmol, 0.5 eq.) to yield dimeric alkyne **28a** (71%, 114 mg, 0.18 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3132, 2944, 2872, 1620, 1592, 1508, 1472, 1432, 1360, 1320, 1300, 1240, 1174, 1136, 1092, 1032, 1000, 932 and 832; δ_H(400 MHz; $CDCl_3$) 8.43 (d, 2 H, *J* 4.6, H-2′, H-2‴), 7.91 (d, 2 H, *J* 9.3, H-8′, H-8‴), 7.43 (d, 2 H, *J* 4.6, H-3′, H-3‴), 7.31 (dd, 2 H, *J* 9.3 and 2.6, H-7′, H-7‴), 7.18 (d, 2 H, *J* 2.6, H-5′, H-5‴), 5.68 (m, 2 H, H-9, H-9″), 3.89 (s, 6 H, H-11′, H-11‴), 3.69–3.61 (m, 2 H, H-8, H-8″), 3.19–3.12 (m, 2 H, H-2, H-2″), 2.91–2.84 (m, 2 H, H-2, H-2″), 2.75–2.51 (m, 4 H, H-6, H-6, H-6″, H-6″), 2.01–1.97 (m, 2 H, H-3, H-3″), 1.88–1.82 (m, 2 H, H-4, H-4″), 1.88–1.64 (m, 6 H, H-5, H-7, H-7, H-5″, H-7″, H-7″) and 1.41–1.33 (m, 2 H, H-5, H-5″); δ_C(100 MHz; $CDCl_3$) 157.77 (C, C-6′, C-6‴), 148.31 (C, C-10′, C-10‴), 147.43 (CH, C-2′, C-2‴), 143.73 (C, C-4′, C-4‴), 131.14 (CH, C-8′, C-8‴), 124.81 (C, C-9′, C-9‴), 121.36 (CH, C-7′, C-7‴),

119.07 (CH, C-3′, C-3‴), 101.32 (CH, C-5′, C-5‴), 81.28 (C, C-10, C-10″), 77.27 (CH, C-9, C-9″), 66.22 (C, C-11, C-11″), 60.39 (CH, C-8, C-8″), 55.95 (CH_3, C-11′, C-11‴), 49.76 (CH_2, C-2, C-2″), 49.33 (CH_2, C-6, C-6″), 29.69 (CH, C-3, C-3″), 28.79 (CH, C-4, C-4″), 24.91 (CH_2, C-7, C-7″) and 21.04 (CH_2, C-5, C-5″); *m*/*z* (FAB) (EI) 643 (M^+ + H, 5%), 356 (10), 341 (11), 295 (9), 281 (41), 267 (19), 207 (48), 189 (28), 159 (29) and 147 (100).

(3*S*,3″*S*,4*S*,4″*S*,8*R*,8″*R*,9*S*,9″*S*)-11,11″-Bi(9-acetoxy-10,11-didehydro-6′-methoxycinchonan) 28b. 10,11-Didehydroquinidine **9a** (100 mg, 0.27 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (10 mg, 0.02 mmol, 0.05 eq.), CuI (5 mg, 0.03 mmol, 0.1 eq.) and iodine (35 mg, 0.14 mmol, 0.5 eq.) to yield dimeric alkyne **28b** (86%, 86 mg, 0.12 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2948, 2876, 1744, 1620, 1592, 1508, 1472, 1456, 1432, 1372, 1320, 1300, 1228, 1136, 1092, 1032, 988 and 844; δ_H(400 MHz; $CDCl_3$) 8.81 (d, 2 H, *J* 4.4, H-2′, H-2‴), 8.11 (d, 2 H, *J* 9.4, H-8′, H-8‴), 7.48 (d, 2 H, *J* 2.7, H-5′, H-5‴), 7.43–7.40 (m, 4 H, H-3′, H-3‴, H-7′, H-7‴), 6.61 (d, 2 H, *J* 6.3, H-9, H-9″), 4.02 (s, 6 H, H-11′, H-11‴), 3.37–3.30 (m, 2 H, H-8, H-8″), 3.21–3.07 (m, 4 H, H-2, H-2, H-2″, H-2″), 2.89–2.80 (m, 2 H, H-6, H-6″), 2.75–2.64 (m, 4 H, H-6, H-6″, H-3, H-3″), 2.24 (s, 6 H, H-13, H-13″), 2.13–2.09 (m, 2 H, H-4, H-4″), 1.67–1.49 (m, 6 H, H-5, H-7, H-7, H-5″, H-7″, H-7″) and 1.38–1.27 (m, 2 H, H-5, H-5″); δ_C(100 MHz; $CDCl_3$) 169.84 (C, C-12, C-12″), 158.01 (C, C-6′, C-6‴), 147.53 (C, C-10′, C-10‴), 144.59 (CH, C-2′, C-2‴), 143.92 (C, C-4′, C-4‴), 131.81 (CH, C-8′, C-8‴), 126.89 (C, C-9′, C-9‴), 121.87 (CH, C-7′, C-7‴), 118.46 (CH, C-3′, C-3‴), 101.50 (CH, C-5′, C-5‴), 80.74 (C, C-10, C-10″), 73.92 (CH, C-9, C-9″), 66.39 (C, C-11, C-11″), 59.05 (CH, C-8, C-8″), 55.69 (CH_3, C-11′, C-11‴), 49.98 (CH_2, C-2, C-2″), 49.41 (CH_2, C-6, C-6″), 28.95 (CH, C-3, C-3″), 27.91 (CH, C-4, C-4″), 24.96 (CH_2, C-7, C-7″), 23.99 (CH_2, C-5, C-5″) and 21.12 (CH_3, C-13, C-13″); *m*/*z* (FAB) (EI) 727.1104 (M^+, $C_{44}H_{46}N_4O_6$ requires 727.1118), 663 (9%), 496 (5), 391 (41), 279 (8) and 149 (86).

(3*S*,3″*S*,4*S*,4″*S*,8*S*,8″*S*,9*R*,9″*R*)-11,11″-Bi(9-acetoxy-10,11-didehydro-6′-methoxycinchonan) 29b. 10,11-Didehydroquinine **10a** (180 mg, 0.49 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (17 mg, 0.025 mmol, 0.05 eq.), CuI (10 mg, 0.05 mmol, 0.1 eq.) and iodine (62 mg, 0.25 mmol, 0.5 eq.) to yield dimeric alkyne **29b** (95%, 171 mg, 0.47 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2956, 2868, 1740, 1672, 1620, 1592, 1508, 1472, 1456, 1432, 1372, 1232, 1092, 1032, 996 and 848; δ_H(400 MHz; $CDCl_3$) 8.76 (d, 2 H, *J* 4.6, H-2′, H-2‴), 8.05 (d, 2 H, *J* 9.2, H-8′, H-8‴), 7.45 (d, 2 H, *J* 2.6, H-5′, H-5‴), 7.40–7.36 (m, 4 H, H-3′, H-3‴, H-7′, H-7‴), 6.49 (d, 2 H, *J* 7.5, H-9, H-9″), 3.95 (s, 6 H, H-11′, H-11‴), 3.59–3.52 (m, 2 H, H-8, H-8″), 3.14–3.04 (m, 4 H, H-2, H-6, H-2″, H-6″), 2.81–2.76 (m, 2 H, H-2, H-2″), 2.63–2.53 (m, 4 H, H-6, H-6″, H-3, H-3″), 2.14 (s, 6 H, H-13, H-13″), 2.13–2.06 (m, 2 H, H-7, H-7″), 2.04 (br s, 2 H, H-4, H-4″), 1.74–1.66 (m, 2 H, H-5, H-5″), 1.58–1.53 (m, 2 H, H-7″, H-7″) and 1.48–1.41 (m, 2 H, H-5, H-5″); δ_C(100 MHz; $CDCl_3$) 170.08 (C, C-12, C-12″), 157.95 (C, C-6′, C-6‴), 147.39 (C, C-2′, C-2‴), 144.65 (CH, C-4′, C-4‴), 143.48 (C, C-10′, C-10‴), 131.69 (CH, C-8′, C-8‴), 127.04 (C, C-9′, C-9‴), 121.90 (CH, C-7′, C-7‴), 119.06 (CH, C-3′, C-3‴), 101.46 (CH, C-5′, C-5‴), 81.15 (C, C-10, C-10″), 73.36 (CH, C-9, C-9″), 65.60 (C, C-11, C-11″), 58.62 (CH, C-8, C-8″), 57.12 (CH_2, C-2, C-2″), 55.63 (CH_3, C-11′, C-11‴), 41.80 (CH_2, C-6, C-6″), 28.25 (CH, C-3, C-3″), 26.98 (CH, C-4, C-4″), 25.96 (CH_2, C-7, C-7″), 24.68 (CH_2, C-5, C-5″) and 21.06 (CH_3, C-13, C-13″); *m*/*z* (FAB) (EI) 727 (M^+, 100).

(1*S*,1′*S*,2*S*,2′*S*,4*S*,4′*S*,5*S*,5′*S*)-1,4-Bis(2-hydroxymethyl-1-azabicyclo[2.2.2]octan-5-yl)buta-1,3-diyne 30. 10,11-Didehydroquincorine **18a** (100 mg, 0.61 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (21 mg, 0.03 mmol, 0.05 eq.), CuI (12 mg, 0.06 mmol, 0.1 eq.) and iodine (77 mg, 0.30 mmol, 0.5 eq.) to yield dimeric alkyne **30** (66%, 66 mg, 0.20 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3456, 3000, 2944, 2868, 1480, 1452, 1412, 1376, 1344, 1324, 1260, 1236, 1132, 1100, 1020, 996 and 936; δ_H(400 MHz; $CDCl_3$) 3.52–3.44 (m, 4 H, H-9, H-9, H-9′, H-9′), 3.32–3.23 (m, 2 H, H-6, H-6′), 3.19–3.06 (m, 2 H, H-2, H-2′), 2.98–2.86 (m, 4 H, H-6, H-6′, H-7, H-7′), 2.68–2.53 (m, 4 H, H-7, H-7′, H-5, H-5′), 2.12–2.03 (m, 2 H, H-3, H-3′), 1.97–1.92 (m, 2 H, H-4, H-4′), 1.54–1.37 (m, 4 H, H-8, H-8, H-8′, H-8′) and 0.89–0.80 (m, 2 H, H-3, H-3′); δ_C(100 MHz; $CDCl_3$) 81.18 (C, C-10, C-10′), 65.68 (C, C-11, C-11′), 62.71 (CH_2, C-9, C-9′), 56.99 (CH, C-2, C-2′), 56.44 (CH_2, C-6, C-6′), 39.59 (CH_2, C-7, C-7′), 28.67 (CH, C-5, C-5′), 26.75 (CH, C-4, C-4′), 26.16 (CH_2, C-8, C-8′) and 24.98 (CH_2, C-3, C-3′); *m*/*z* (MAT, 170 °C) (EI) 328.2152 (M^+, $C_{20}H_{28}N_2O_2$ requires 328.2151), 311 (7%), 297 (91), 270 (40), 255 (11), 239 (49), 212 (42), 196 (14), 184 (34), 166 (17), 112 (37) and 86 (81).

(1*S*,1′*S*,2*R*,2′*R*,4*S*,4′*S*,5*S*,5′*S*)-1,4-Bis(2-hydroxymethyl-1-azabicyclo[2.2.2]octan-5-yl)buta-1,3-diyne 31a. 10,11-Didehydroquincoridine **20a** (100 mg, 0.61 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (21 mg, 0.03 mmol, 0.05 eq.), CuI (12 mg, 0.06 mmol, 0.1 eq.) and iodine (77 mg, 0.30 mmol, 0.5 eq.) to yield dimeric alkyne **31a** (64%, 64 mg, 0.19 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3412, 3000, 2948, 2876, 1452, 1412, 1376, 1320, 1296, 1252, 1236, 1188, 1136, 1100, 1060, 1028, 940 and 864; δ_H(400 MHz; $CDCl_3$) 5.36–5.21 (s, 2 H, OH, OH′), 3.75–3.67 (dd, 2 H, *J* 12.2 and 10.3, H-9, H-9′), 3.56–3.52 (dd, 2 H, *J* 12.1 and 4.5, H-9, H-9′), 3.13–2.86 (m, 10 H, H-6, H-6′, H-2, H-2′, H-6, H-6′, H-7, H-7′, H-7, H-7′), 2.72–2.65 (m, 2 H, H-5, H-5′), 2.06–1.99 (m, 2 H, H-4, H-4′), 1.75–1.57 (m, 6 H, H-3, H-3′, H-8, H-8′, H-8, H-8′) and 1.51–1.45 (m, 2 H, H-3, H-3′); δ_C(100 MHz; $CDCl_3$) 79.91 (C, C-10, C-10′), 66.43 (C, C-11, C-11′), 61.89 (CH_2, C-9, C-9′), 57.86 (CH, C-2, C-2′), 48.06 (CH_2, C-6, C-6′), 46.99 (CH_2, C-7, C-7′), 28.72 (CH, C-5, C-5′), 27.29 (CH, C-4, C-4′), 24.86 (CH_2, C-8, C-8′) and 24.07 (CH_2, C-3, C-3′); *m*/*z* (MAT, 170 °C) (EI) 328.2143 (M^+, $C_{20}H_{28}N_2O_2$ requires 328.2151), 311 (7%), 298 (62), 270 (22), 256 (9), 239 (18), 212 (12), 202 (22), 184 (26), 170 (9), 149 (11), 126 (23), 112 (21) and 82 (21).

(1*S*,1′*S*,2*R*,2′*R*,4*S*,4′*S*,5*S*,5′*S*)-1,4-Bis(2-*tert*-butyldimethylsilanyloxymethyl-1-azabicyclo[2.2.2]octan-5-yl)buta-1,3-diyne 31b. 10,11-Didehydroquincoridine **20b** (200 mg, 0.72 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (33 mg, 0.036 mmol, 0.05 eq.), CuI (14 mg, 0.07 mmol, 0.1 eq.) and iodine (182 mg, 0.31 mmol, 0.5 eq.) to yield dimeric alkyne **31b** (85%, 169 mg, 0.30 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2948, 2880, 2856, 1468, 1388, 1360, 1320, 1300, 1256, 1148, 1116, 1080, 1052, 1020, 936 and 836; δ_H(400 MHz; $CDCl_3$) 3.77–3.67 (m, 4 H, H-9, H-9′, H-9, H-9′), 3.07–3.02 (m, 4 H, H-6, H-6′, H-2, H-2′), 2.99–2.92 (m, 2 H, H-6, H-6′), 2.89–2.74 (m, 4 H, H-7, H-7′, H-7, H-7′), 2.59–2.54 (m, 2 H, H-5, H-5′), 2.00–1.95 (m, 2 H, H-4, H-4′), 1.79–1.72 (m, 2 H, H-3, H-3′), 1.66–1.48 (m, 6 H, H-8, H-8, H-8′, H-8′, H-3, H-3′), 0.93 (s, 9 H, SiC$(CH_3)_3$), 0.92 (s, 9 H, SiC$(CH_3)_3$), 0.10 (s, 6 H, SiCH_3) and 0.09 (s, 6 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 80.63 (C, C-10, C-10′), 66.19 (C, C-11, C-11′), 65.22 (CH_2, C-9, C-9′), 57.30 (CH, C-2, C-2′), 49.18 (CH_2, C-6, C-6′), 48.82 (CH_2, C-7, C-7′), 29.02 (CH, C-5, C-5′), 27.82 (CH, C-4, C-4′), 26.03 (CH_3, SiC$(CH_3)_3$), 25.22 (CH_2, C-8, C-8′), 25.05 (CH_2, C-3, C-3′), 18.45 (C, Si$C(CH_3)_3$), −5.23 (CH_3, SiCH_3) and −5.27 (CH_3, SiCH_3); *m*/*z* (MAT, 150 °C) (EI) 556.3889 (M^+, $C_{32}H_{56}N_2O_2Si_2$ requires 556.3880), 541 (11%), 499 (100), 443 (3), 425 (3), 411 (21), 384 (20), 368 (7), 326 (72), 298 (2), 279 (9), 238 (26), 222 (85), 202 (53), 185 (37), 155 (17), 110 (14), 89 (8) and 73 (60).

(1′*S*,1″*S*,2′*S*,2″*S*,4′*S*,4″*S*,5′*S*,5″*S*)-(*Z*)-1,2-Bis(2-*tert*-butyldimethylsilanyloxymethyl-1-azabicyclo[2.2.2]octan-5-ylethynyl)-ethene 32. 10,11-Didehydroquincorine **18b** (200 mg, 0.72 mmol,

1 eq.) was allowed to react with $(Ph_3P)_2PdCl_2$ (33 mg, 0.036 mmol, 0.05 eq.), CuI (14 mg, 0.072 mmol, 0.1 eq.) and (*Z*)-1,2-dichloroethene (27 μl, 0.36 mmol, 0.5 eq.) in Pr^i_2NH–THF (3:1) to yield (*Z*)-enediyne **32** (79%, 144 mg, 0.25 mmol) which partially isomerized to the corresponding (*E*)-isomer upon storage (1 d) in $CHCl_3$ at rt (*E*:*Z* = 18:32); $\nu_{max}(CHCl_3)$/cm^{-1} 2928, 2856, 1468, 1320, 1264, 1116, 1084, 1028 and 836; δ_H(400 MHz; $CDCl_3$) 6.34 (d, 2 H, J_{cis} 7.4, H-12, H-13), 5.89 (dd, 2 H, J_{trans} 13.2 and 1.6, H-12, H-13), 3.69–3.65 (dd, 2 H, *J* 10.3 and 6.0, H-9′, H-9″), 3.63–3.59 (dd, 2 H, *J* 10.4 and 6.1, H-9′, H-9″), 3.24–3.17 (dd, 2 H, *J* 13.4 and 10.0, H-6_{endo}′, H-6_{endo}″), 3.07–2.87 (m, 4 H, H-2′, H-2″, H-6′, H-6″), 2.62–2.53 (m, 4 H, H-7′, H-7″, H-7′, H-7″), 2.32–2.27 (m, 2 H, H-5′, H-5″), 2.07–1.99 (m, 2 H, H-4′, H-4″), 1.96–1.91 (m, 2 H, H-3′, H-3″), 1.54–1.32 (m, 6 H, H-8′, H-8″, H-8′, H-8″, H-3′, H-3″), 0.89 (s, 18 H, SiC(CH_3)$_3$) and 0.06 (s, 12 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 112.41 (CH, C-12, C-13), 81.48 (C, C-10′, C-10″), 65.89 (C, C-11′, C-11″), 65.52 (CH_2, C-9′, C-9″), 57.92 (CH, C-2′, C-2″), 57.02 (CH_2, C-6′, C-6″), 41.70 (CH_2, C-7′, C-7″), 29.30 (CH, C-5′, C-5″), 27.64 (CH, C-4′, C-4″), 26.01 (CH_3, SiC(CH_3)$_3$), 25.08 (CH_2, C-8′, C-8″), 22.67 (CH_2, C-3′, C-3″), 18.41 (C, SiC(CH_3)$_3$), −5.32 (CH_3, SiCH_3) and −5.35 (CH_3, SiCH_3); *m*/*z* (FAB) (EI) 584 (M^+ + 2 H, 2), 557 (100), 542 (8), 500 (37), 411 (5), 310 (6) and 282 (16).

(1′*S*,1″*S*,2′*R*,2″*R*,4′*S*,4″*S*,5′*S*,5″*S*)-1,4-Bis(2-hydroxymethyl-1-azabicyclo[2.2.2]octan-5-ylethynyl)benzene 33. 10,11-Didehydroquincoridine **20a** (100 mg, 0.61 mmol, 1 eq.) was allowed to react according to the general procedure with $(Ph_3P)_2PdCl_2$ (21 mg, 0.03 mmol, 0.05 eq.), CuI (12 mg, 0.06 mmol, 0.1 eq.) and 1,4–diiodobenzene (99 mg, 0.30 mmol, 0.5 eq.) to yield dimeric alkyne **33** (64%, 64 mg, 0.19 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 3416, 3000, 2948, 2876, 2224, 1484, 1464, 1412, 1388, 1324, 1256, 1236, 1160, 1136, 1100, 1056, 1028, 1008, 944 and 820; δ_H(400 MHz; $CDCl_3$) 7.63 (d, 4 H, *J* 8.4, H-2, H-3, H-5, H-6), 5.42–5.33 (s, 2 H, OH, OH′), 3.73–3.56 (m, 4 H, H-9′, H-9″, H-9′, H-9″), 3.18–2.81 (m, 10 H, H-6′, H-6″, H-2′, H-2″, H-6′, H-6″, H-7′, H-7″, H-7′, H-7″), 2.69–2.61 (m, 2 H, H-5′, H-5″), 2.00–1.92 (m, 2 H, H-4′, H-4″), 1.79–1.52 (m, 6 H, H-3′, H-3″, H-8′, H-8″, H-8′, H-8″) and 1.46–1.33 (m, 2 H, H-3′, H-3″); δ_C(100 MHz; $CDCl_3$) 133.17 (CH, C-2, C-3, C-5, C-6), 122.95 (C, C-1, C-4), 93.52 (C, C-10′, C-10″), 81.08 (C, C-11′, C-11″), 61.91 (CH_2, C-9′, C-9″), 57.48 (CH, C-2′, C-2″), 48.35 (CH_2, C-6′, C-6″), 47.76 (CH_2, C-7′, C-7″), 29.11 (CH, C-5′, C-5″), 27.31 (CH, C-4′, C-4″), 24.16 (CH_2, C-8′, C-8″) and 22.57 (CH_2, C-3′, C-3″); *m*/*z* (FAB) (EI) 425 (M^+ − 2 H + Na, 9%), 397 (18), 368 (100), 336 (14), 281 (15), 221 (20) and 147 (35).

(1′*S*,1″*S*,2′*S*,2″*S*,4′*S*,4″*S*,5′*S*,5″*S*)-1,2-Bis(2-*tert*-butyldimethylsilanyloxymethyl-1-azabicyclo[2.2.2]octanyl)benzene 34. Enediyne **32** (58 mg, 0.10 mmol) cycloaromatized upon refluxing in $CHCl_3$ for 4 h furnishing aromatic dimer **34** (86%, 50 mg, 0.09 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 2952, 2928, 2856, 1592, 1468, 1388, 1360, 1332, 1304, 1256, 1120, 1084, 1028, 1004, 936 and 836; δ_H(400 MHz; $CDCl_3$) 7.71–7.65 (m, 2 H, H-3, H-6), 7.51–7.46 (m, 2 H, H-4, H-5), 3.73–3.62 (m, 4 H, H-9′, H-9″, H-9′, H-9″), 3.31–3.25 (dd, 2 H, *J* 13.2 and 10.0, H-6_{endo}′, H-6_{endo}″), 3.12–2.90 (m, 4 H, H-2′, H-2″, H-6′, H-6″), 2.75–2.59 (m, 4 H, H-7′, H-7″, H-7′, H-7″), 2.40–2.36 (m, 2 H, H-5′, H-5″), 2.18–2.10 (m, 2 H, H-4′, H-4″), 2.03–1.95 (m, 2 H, H-3′, H-3″), 1.61–1.37 (m, 6 H, H-8′, H-8″, H-8′, H-8″, H-3′, H-3″), 0.92 (s, 18 H, SiC(CH_3)$_3$) and 0.09 (s, 12 H, SiCH_3); δ_C(100 MHz; $CDCl_3$) 132.17 (CH, C-3, C-6), 128.58 (CH, C-4, C-5), 127.25 (C, C-1, C-2), 65.86 (CH_2, C-9′, C-9″), 57.72 (CH, C-2′, C-2″), 57.09 (CH_2, C-6′, C-6″), 41.75 (CH_2, C-7′, C-7″), 28.88 (CH, C-5′, C-5″), 27.59 (CH, C-4′, C-4″), 26.02 (CH_3, SiC(CH_3)$_3$), 25.23 (CH_2, C-8′, C-8″), 22.70 (CH_2, C-3′, C-3″), 18.44 (C, SiC(CH_3)$_3$), −5.30 (CH_3, SiCH_3) and −5.32 (CH_3, SiCH_3); *m*/*z* (FAB) (EI) 586 (M^+ + 2 H, 13), 578 (71), 552 (73), 519 (100), 437 (43), 397 (45), 355 (63), 341 (63) and 327 (85).

General procedure for the Heck reaction of *Cinchona* alkaloid precursors with α,β-unsaturated carbonyl compounds

$Pd(OAc)_2$ (0.05 eq.), K_2CO_3 (2.50 eq.) and TBAI (1.00 eq.) were dissolved in absolute DMF under argon. The reaction mixture was stirred for 15 min at rt, the α,β-unsaturated carbonyl compound (4.00 eq.) was added and stirring was continued for 15 min, followed by dropwise addition of a solution of vinyl iodide precursor (1.50 eq.) in absolute DMF. Subsequent to stirring at rt for 12 h, the dark-red reaction mixture was treated with sat. aq. $NaHCO_3$ and sat. aq. NaCl. The aqueous layer was thorougly extracted with CH_2Cl_2 and the combined organic layer was dried ($MgSO_4$) and concentrated under reduced pressure. DMF was then removed at elevated temperature under reduced pressure. The resulting crude product was purified by column chromatography (EtOAc–MeOH 20:1) to yield the desired coupling product.

(3*R*,4*S*,8*R*,9*S*,10*Z*)-9-Acetoxy-11-[(4*E*)-3-oxobutylidene]-6′-methoxycinchonan 35a. (*Z*)-11-(2-Iodovinyl)quinidine **11b** (121 mg, 0.25 mmol, 1 eq.) was allowed to react according to the general procedure with $Pd(OAc)_2$ (3 mg, 0.01 mmol, 0.05 eq.), K_2CO_3 (85 mg, 0.62 mmol, 2.5 eq.), TBAI (91 mg, 0.25 mmol, 1 eq.) and methylvinyl ketone (82 μl, 0.99 mmol, 4.0 eq.) to afford (*Z*,*E*)-diene **35a** (92%, 98 mg, 0.23 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 2944, 2876, 1744, 1668, 1620, 1588, 1508, 1472, 1456, 1432, 1360, 1296, 1236, 1176, 1136, 1084, 1028, 992 and 844; δ_H(400 MHz; $CDCl_3$) 8.73 (d, 1 H, *J* 4.5, H-2′), 8.02 (d, 1 H, *J* 9.9, H-8′), 7.41–7.35 (m, 3 H, H-7′, H-5′, H-12), 7.33 (d, 1 H, *J* 4.6, H-3′), 6.57 (d, 1 H, *J* 6.8, H-9), 6.24 (d, 1 H, *J* 9.2, H-10), 6.23 (d, 1 H, *J* 15.3, H-13), 6.16 (m, 1 H, H-11), 3.93 (s, 3 H, H-11′), 3.35–3.30 (m, 2 H, H-8, H-2), 3.06–2.97 (m, 1 H, H-2), 2.89–2.78 (m, 3 H, H-6, H-6, H-3), 2.28 (s, 3 H, H-15), 2.14 (s, 3 H, H-17), 1.94–1.88 (m, 1 H, H-4), 1.81–1.76 (m, 1 H, H-7) and 1.71–1.42 (m, 3 H, H-7, H-5, H-5); δ_C(100 MHz; $CDCl_3$) 198.45 (C, C-14), 169.93 (C, C-16), 157.97 (C, C-6′), 147.41 (CH, C-2′), 144.72 (C, C-10′), 143.66 (C, C-4′), 143.45 (CH, C-12), 137.88 (CH, C-13), 131.83 (CH, C-8′), 130.83 (CH, C-11), 127.54 (CH, C-10), 126.92 (C, C-9′), 121.81 (CH, C-7′), 118.53 (CH, C-3′), 101.43 (CH, C-5′), 73.42 (CH, C-9), 58.82 (CH, C-8), 55.68 (CH_3, C-11′), 50.07 (CH_2, C-2), 49.67 (CH_2, C-6), 34.88 (CH, C-3), 28.26 (CH, C-4), 25.91 (CH_2, C-7), 23.13 (CH_2, C-5), 21.17 (CH_3, C-17) and 13.73 (CH_3, C-15); *m*/*z* (MAT, 140 °C) (EI) 434.2206 (M^+, $C_{26}H_{30}N_2O_4$ requires 434.2205), 391 (1%), 373 (1), 315 (1), 285 (2), 258 (8), 204 (6), 167 (4), 155 (7), 139 (5), 111 (6), 99 (37) and 83 (100).

(3*R*,4*S*,8*R*,9*S*,10*E*)-11-(3-Oxopropylidene-6′-methoxycinchonan-9-ol 35b. (*Z*)-11-(2-Iodovinyl)quinidine **11a** (111 mg, 0.25 mmol, 1 eq.) was allowed to react according to the general procedure with $Pd(OAc)_2$ (3 mg, 0.01 mmol, 0.05 eq.), K_2CO_3 (85 mg, 0.62 mmol, 2.5 eq.), TBAI (91 mg, 0.25 mmol, 1 eq.) and methyl acrylate (90 μl, 0.99 mmol, 4.0 eq.) to afford (*Z*,*E*)-diene **35b** (68%, 69 mg, 0.17 mmol); $\nu_{max}(CHCl_3)$/cm^{-1} 3336, 2964, 2876, 1620, 1592, 1508, 1460, 1436, 1384, 1296, 1276, 1228, 1176, 1140, 1104, 1064, 1028, 992 and 872; δ_H(400 MHz; $CDCl_3$) 8.76 (d, 1 H, *J* 4.6, H-2′), 7.90 (d, 1 H, *J* 9.2, H-8′), 7.76 (d, 1 H, *J* 4.6, H-3′), 7.25–7.19 (m, 2 H, H-7′, H-5′), 6.83 (s, 1 H, H-9), 6.37–6.30 (m, 2 H, H-11, H-12), 6.26 (d, 1 H, *J* 9.2, H-10), 5.99 (d, 1 H, *J* 15.2, H-13), 3.87 (s, 3 H, H-11′), 3.76 (s, 3 H, H-15), 3.71–3.63 (m, 1 H, H-8), 3.56–3.42 (m, 2 H, H-2, H-2), 3.31–3.18 (m, 2 H, H-6, H-6), 2.52–2.45 (m, 1 H, H-3), 2.14–1.98 (m, 2 H, H-4, H-7), 1.73–1.65 (m, 1 H, H-7) and 1.50–1.42 (m, 2 H, H-5, H-5); δ_C(100 MHz; $CDCl_3$) 167.26 (C, C-14), 158.73 (C, C-6′), 147.23 (CH, C-2′), 144.93 (C, C-10′), 143.84 (C, C-4′), 143.31 (CH, C-12), 137.94 (CH, C-13), 131.30 (CH, C-8′), 130.93 (CH, C-11), 129.29 (CH, C-10),

125.66 (C, C-9′), 123.60 (CH, C-7′), 119.19 (CH, C-3′), 100.48 (CH, C-5′), 73.90 (CH, C-9), 60.16 (CH, C-8), 59.23 (CH_3, C-15), 58.58 (CH_3, C-11′), 51.82 (CH_2, C-2), 49.89 (CH_2, C-6), 38.72 (CH, C-3), 28.92 (CH, C-4), 24.34 (CH_2, C-7) and 23.74 (CH_2, C-5); *m*/*z* (MAT, 140 °C) (EI) 408.3244 (M^+, $C_{24}H_{28}N_2O_4$ requires 408.3239), 377 (2%), 335 (8), 323 (5), 279 (15), 254 (2), 220 (14), 167 (32), 149 (100), 127 (19), 113 (11), 87 (13), 71 (21).

(3*R*,4*S*,8*R*,9*S*,11*Z*)-9-Acetoxy-11-(3-*tert*-butoxycarbonyl-propylidene)-6′-methoxycinchonan 35c. (*Z*)-11-(2-Iodovinyl)-quinidine **11b** (121 mg, 0.25 mmol, 1 eq.) was allowed to react according to the general procedure with $Pd(OAc)_2$ (3 mg, 0.01 mmol, 0.05 eq.), K_2CO_3 (85 mg, 0.62 mmol, 2.5 eq.), TBAI (91 mg, 0.25 mmol, 1 eq.) and isobutyl acrylate (0.14 ml, 0.99 mmol, 4.0 eq.) to afford (*Z*,*E*)-diene **35c** (88%, 106 mg, 0.22 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2964, 2876, 1744, 1672, 1632, 1508, 1472, 1432, 1376, 1308, 1268, 1228, 1176, 1140, 1112, 1084, 1028, 992 and 872; δ_H(400 MHz; $CDCl_3$) 8.69 (d, 1 H, *J* 4.5, H-2′), 7.97 (d, 1 H, *J* 9.2, H-8′), 7.49 (dd, 1 H, *J* 15.2 and 11.6,H-12), 7.38–7.35 (m, 2 H, H-7′, H-5′), 7.32 (d, 1 H, *J* 4.5, H-3′), 6.74 (d, 1 H, *J* 6.6, H-9), 6.26 (dd, 1 H, *J* 11.6 and 9.2, H-11), 6.14 (d, 1 H, *J* 9.2, H-10), 5.95 (d, 1 H, *J* 15.2, H-13), 3.94 (s, 3 H, H-11′), 3.91 (d, 2 H, *J* 6.7, H-15), 3.69–3.61 (m, 1 H, H-8), 3.42–3.23 (m, 2 H, H-2, H-2), 2.99–2.82 (m, 3 H, H-6, H-6, H-3), 2.14 (s, 3 H, H-20), 2.02–1.93 (m, 1 H, H-4), 1.83–1.79 (m, 1 H, H-7), 1.69–1.57 (m, 3 H, H-7, H-5, H-5), 1.45–1.37 (m, 1 H, H-16) and 0.97–0.89 (m, 6 H, H-17, H-18); δ_C(100 MHz; $CDCl_3$) 169.42 (C, C-19), 167.51 (C, C-14), 158.09 (C, C-6′), 147.34 (CH, C-2′), 144.84 (C, C-10′), 143.39 (C, C-4′), 143.02 (CH, C-12), 138.71 (CH, C-13), 131.82 (CH, C-8′), 127.78 (CH, C-11), 126.55 (C, C-9′), 122.76 (CH, C-10), 122.15 (CH, C-7′), 118.32 (CH, C-3′), 101.29 (CH, C-5′), 72.69 (CH, C-9), 70.61 (CH_2, C-15), 58.81 (CH, C-8), 55.61 (CH_3, C-11′), 49.82 (CH_2, C-2), 49.27 (CH_2, C-6), 34.07 (CH, C-3), 27.78 (CH, C-4), 25.68 (CH_2, C-7), 24.30 (CH_2, C-5), 21.13 (CH_3, C-20), 19.12 (CH, C-16) and 13.76 (CH_3, C-17, C-18); *m*/*z* (FAB) (EI) 493 (M^+ + H, 17), 242 (100), 184 (8) and 142 (9).

(3*R*,4*S*,8*R*,9*S*,11*Z*)-9-Acetoxy-11-(3-oxopropylidene)-6′-methoxycinchonan 35d. (*Z*)-11-(2-Iodovinyl)quinidine **11b** (121 mg, 0.25 mmol, 1 eq.) was allowed to react according to the general procedure with $Pd(OAc)_2$ (3 mg, 0.01 mmol, 0.05 eq.), K_2CO_3 (85 mg, 0.62 mmol, 2.5 eq.), TBAI (91 mg, 0.25 mmol, 1 eq.) and acrolein (66 μl, 0.99 mmol, 4.0 eq.) to afford (*Z*,*E*)-diene **35d** (81%, 84 mg, 0.20 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 3000, 2944, 2876, 1744, 1676, 1624, 1588, 1508, 1472, 1456, 1432, 1364, 1304, 1228, 1172, 1136, 1088, 1032, 988 and 844; δ_H(400 MHz; $CDCl_3$) 9.61 (d, 1 H, *J* 7.5, H-14), 8.70 (d, 1 H, *J* 4.6, H-2′), 7.98 (d, 1 H, *J* 9.2, H-8′), 7.40–7.30 (m, 4 H, H-7′, H-5′, H-12, H-3′), 6.55 (m, 1 H, H-9), 6.40–6.25 (m, 2 H, H-10, H-11), 6.20–6.10 (m, 1 H, H-13), 3.92 (s, 3 H, H-11′), 3.38–3.24 (m, 3 H, H-8, H-2, H-2), 3.05–2.75 (m, 3 H, H-6, H-6, H-3), 2.13 (s, 3 H, H-16), 1.96–1.85 (m, 1 H, H-4) and 1.71–1.35 (m, 4 H, H-7, H-7, H-5, H-5); δ_C(100 MHz; $CDCl_3$) 193.79 (CH, C-14), 169.88 (C, C-15), 157.91 (C, C-6′), 147.36 (CH, C-2′), 146.27 (CH, C-12), 144.95 (C, C-10′), 144.80 (C, C-4′), 143.59 (CH, C-13), 132.40 (CH, C-11), 131.77 (CH, C-8′), 127.41 (CH, C-10), 126.98 (C, C-9′), 121.85 (CH, C-7′), 118.31 (CH, C-3′), 101.42 (CH, C-5′), 73.31 (CH, C-9), 58.76 (CH, C-8), 55.53 (CH_3, C-11′), 49.89 (CH_2, C-2), 49.42 (CH_2, C-6), 34.97 (CH, C-3), 28.08 (CH, C-4), 25.11 (CH_2, C-7), 23.47 (CH_2, C-5) and 21.13 (CH_3, C-16); *m*/*z* (MAT, 90 °C) (EI) 420.2048 (M^+, $C_{25}H_{28}N_2O_4$ requires 420.2049), 392 (8%), 378 (10), 361 (14), 349 (2), 325 (16), 294 (2), 265 (6), 242 (100), 231 (32), 211 (28), 190 (31), 173 (11), 155 (10), 142 (60), 128 (24), 99 (41) and 91 (41).

(3*R*,4*S*,8*R*,9*S*,11*Z*)-9-Acetoxy-11-(2-carbamoylethylidene)-6′-methoxycinchonan 35e. (*Z*)-11-(2-Iodovinyl)quinidine **11b** (121 mg, 0.25 mmol, 1 eq.) was allowed to react according to the general procedure with $Pd(OAc)_2$ (3 mg, 0.01 mmol, 0.05 eq.), K_2CO_3 (85 mg, 0.62 mmol, 2.5 eq.), TBAI (91 mg, 0.25 mmol, 1 eq.) and acrylamide (70 mg, 0.99 mmol, 4.0 eq.) to afford (*Z*,*E*)-diene **35d** (90%, 96 mg, 0.22 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2940, 2876, 1744, 1676, 1624, 1592, 1508, 1472, 1456, 1432, 1372, 1304, 1228, 1156, 1120, 1084, 1032, 988 and 956; δ_H(400 MHz; $CDCl_3$) 8.72 (d, 1 H, *J* 4.5, H-2′), 8.01 (d, 1 H, *J* 9.9, H-8′), 7.51 (dd, 1 H, *J* 14.9 and 11.2, H-12), 7.36–7.32 (m, 3 H, H-7′, H-5′, H-3′), 6.53 (d, 1 H, *J* 6.7, H-9), 6.20–6.08 (m, 2 H, H-10, H-11), 5.99 (d, 1 H, *J* 14.8, H-13), 3.92 (s, 3 H, H-11′), 3.32–3.23 (m, 3 H, H-8, H-2, H-2), 3.00–2.71 (m, 3 H, H-6, H-6, H-3), 2.13 (s, 3 H, H-16), 1.91–1.85 (m, 1 H, H-7), 1.76–1.72 (m, 1 H, H-4) and 1.67–1.38 (m, 3 H, H-7, H-5, H-5); δ_C(100 MHz; $CDCl_3$) 170.02 (C, C-14), 168.23 (C, C-15), 157.85 (C, C-6′), 147.35 (CH, C-2′), 144.59 (C, C-10′), 143.47 (C, C-4′), 141.62 (CH, C-12), 136.76 (CH, C-13), 132.05 (CH, C-11), 131.69 (CH, C-8′), 126.88 (C, C-9′), 123.93 (CH, C-10), 121.86 (CH, C-7′), 118.56 (CH, C-3′), 101.44 (CH, C-5′), 73.51 (CH, C-9), 58.84 (CH, C-8), 55.63 (CH_3, C-11′), 49.92 (CH_2, C-2), 49.35 (CH_2, C-6), 34.53 (CH, C-3), 27.98 (CH, C-4), 25.31 (CH_2, C-7), 24.09 (CH_2, C-5) and 21.19 (CH_3, C-16); *m*/*z* (MAT, 70 °C) (EI) 436.2224 (M^+, $C_{25}H_{30}N_3O_4$ requires 436.2236), 420 (2%), 392 (2), 376 (11), 349 (1), 242 (2), 231 (2), 205 (100), 189 (17), 173 (10), 154 (10), 142 (25), 132 (8), 95 (4) and 79 (8).

(1*S*,2*S*,4*S*,5*R*)-2-*tert*-Butylsilanyloxymethyl-5-[(1*E*,3*E*)-5-oxohexa-1,3-dienyl]-1-azabicyclo[2.2.2]octane 36. (*E*)-11-(2-Iodovinyl)quincorine **17** (68 mg, 0.17 mmol, 1 eq.) was allowed to react according to the general procedure with $Pd(OAc)_2$ (2 mg, 0.01 mmol, 0.05 eq.), K_2CO_3 (57 mg, 0.42 mmol, 2.5 eq.), TBAI (62 mg, 0.17 mmol, 1 eq.) and methyl vinyl ketone (47 mg, 0.67 mmol, 4.0 eq.) to afford (*Z*,*E*)-diene **36** (84%, 49 mg, 0.14 mmol); $\nu_{max}(CHCl_3)/cm^{-1}$ 2960, 2936, 2876, 1672, 1632, 1468, 1408, 1384, 1360, 1316, 1256, 1232, 1112, 1092, 1064, 996 and 836; δ_H(400 MHz; $CDCl_3$) 7.13–7.03 (dd, 1 H, *J* 15.6 and 9.7, H-12), 6.32–6.20 (m, 2 H, H-10, H-11), 6.08–6.03 (d, 1 H, *J* 15.7, H-13), 3.74–3.68 (m, 2 H, H-9, H-9), 3.65–3.42 (m, 3 H, H-6, H-6, H-2), 3.20–2.95 (m, 2 H, H-7, H-7), 2.35–2.32 (m, 1 H, H-5), 2.22 (s, 3 H, H-15), 2.12–2.04 (m, 2 H, H-4, H-3), 1.95–1.74 (m, 3 H, H-8, H-8, H-3), 0.89 (s, 9 H, SiC*(CH$_3$)$_3$*), 0.07 (s, 3 H, Si*CH$_3$*) and 0.05 (s, 3 H, Si*CH$_3$*); δ_C(100 MHz; $CDCl_3$) 198.73 (C, C-14), 142.82 (CH, C-12), 130.62 (CH, C-13), 130.58 (CH, C-11), 130.42 (CH, C-10), 62.64 (CH_2, C-9), 58.14 (CH, C-2), 54.01 (CH_2, C-6), 42.79 (CH_2, C-7), 27.60 (CH, C-5), 26.81 (CH, C-4), 25.97 (CH_3, SiC(*C*H$_3$)$_3$), 24.69 (CH_2, C-8), 24.31 (CH_2, C-3), 22.15 (CH_3, C-15), 18.28 (C, Si*C*(CH$_3$)$_3$), −5.20 (CH_3, Si*C*H$_3$) and −5.38 (CH_3, Si*C*H$_3$); *m*/*z* (FAB) (EI) 350 (M^+ + H, 23), 242 (100), 184 (10) and 142 (17).

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