# [Ag(PcL)]-Catalysed Domino Approach to6-Substituted Benzoxazino Isoquinolines

Davide Garanzini,<sup>a</sup> Valentina Pirovano,<sup>a</sup> Ilaria Menghi,<sup>a,b</sup> Giuseppe Celentano,<sup>a</sup>

Silvia Rizzato,<sup>b</sup> Elisabetta Rossi,<sup>a</sup> Alessandro Caselli,<sup>b,c</sup> and Giorgio Abbiati<sup>\*,a</sup>

<sup>a</sup> Dipartimento di Scienze Farmaceutiche, Sezione di Chimica Generale e Organica "A. Marchesini", Università degli Studi di Milano, Via Venezian, 21–20133 Milano–Italy

<sup>b</sup> Dipartimento di Chimica, Università degli Studi di Milano and CNR-SCITEC, Via Golgi, 19–20133 Milano–Italy

° CNR-SCITEC, Via Golgi, 19-20133 Milano-Italy

E-mail: giorgio.abbiati@unimi.it

# **Supporting Information**

#### Table of Contents:

X-ray Single-Crystal Structure Determination	S2
Figure 1S	S2
References	S2
Table 1S. Summary of X-ray single crystal diffraction refinement results for 3e.	S3
<b>Table 2S</b> . Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å2) for <b>3e</b> .	S4
Table 3S. Geometric parameters (Å, °) for 3e.	S5
<sup>1</sup> H, <sup>13</sup> C and two-dimensional NMR spectra of compounds $3$	S7
HPLC spectra of compounds <b>3</b> and <b>3'</b>	S45

#### X-ray Single-Crystal Structure Determination.

Crystal data and structure determination results are summarized in Table 1S. X-ray data collection was carried out at 180 K using graphite-monochromated Mo K $\alpha$  radiation ( $\lambda = 0.71073$  Å) on a Bruker SMART-APEX II diffractometer equipped with an Oxford Cryosystems N<sub>2</sub> gas blower. A  $\omega$ -scan at three different  $\varphi$  settings and a detector position of -30° in 20 was performed within the Bragg limits of  $1.5 < \theta < 27.7^{\circ}$ . Determination of the integrated intensities and unit cell refinements were performed using SAINT<sup>1</sup>. The intensity data were corrected for absorption by using SADABS.<sup>1</sup> No *decay correction* was applied. The structures were solved by direct methods (SIR2014)<sup>2</sup> and refined by full-matrix least squares on F<sup>2</sup> (SHELX 2014)<sup>3</sup> with the WINGX interface.<sup>4</sup>

All hydrogen atoms were located from the difference Fourier map and refined as "riding" on the adjacent carbon with individual isotropic temperature factor 1.2 or 1.5 (H-methyl group) times the value of the equivalent temperature factor of the parent atom. All non-hydrogen atoms were *refined with* full occupancy and *anisotropic displacement parameters*. The diagram was drawn using ORTEPIII program.<sup>5</sup>

- 1. Bruker. SADABS and SAINT 2009, Bruker AXS Inc., Madison, Wisconsin, USA.
- 2. Burla, M. C.; Caliandro, R.; Camalli, M.; Carrozzini, B.; Cascarano, G. L.; De Caro, L.; Giacovazzo, C.; Polidori, G.; Spagna, R. *J. Appl. Crystallogr.* **2005**, *38* (2), 381–388.
- 3. Sheldrick, G. M. Acta Crystallogr. Sect. C Struct. Chem. 2015, 71, 3-8.
- 4. Farrugia, L. J. J. Appl. Crystallogr. 2012, 45 (4), 849-854.
- 5. M. N. Burnett and C. K. Johnson, ORTEP-III Report ORNL-6895. Oak Ridge National Laboratory, Tennessee, USA, 1996.



**Figure 1S:** The molecular structure of compound **3e** showing the numbering schemes for some nonhydrogen atoms. Displacement ellipsoids are plotted at the 40% probability level.

Identification code	3f
Empirical formula	C <sub>24</sub> H <sub>21</sub> NO
Formula weight	339.42
Temperature (K)	180(2)
Wavelength (Å)	0.71073
Crystal system	Monoclinic
Space group	$P2_{1}/c$
Unit cell dimensions	a = 14.0503(6) Å
	b = 5.6227(3) Å
	c = 22.727(1) Å
	$\beta = 97.907(1)^{\circ}$
Volume (Å <sup>3</sup> )	1778.38(14)
Ζ	4
Density (calculated) (g/cm <sup>3</sup> )	1.268
Absorption coefficient $\mu$ (mm <sup>-1</sup> )	0.077
<i>F</i> (000)	720
$T_{\min}, T_{\max}$	0.692, 0.746
Theta range for data collection	1.5 to 27.7°
Index ranges	-18<=h<=18, -7<=k<=7, - 29<=l<=29
$(\sin \theta / \lambda)_{max} (\text{\AA}^{-1})$	0.654
Reflections collected	16557
Independent reflections	4171 [ $R_{\rm int} = 0.0164$ ]
Observed reflections [I>2sigma(I)]	3707
Completeness to theta	100.0 %
Data / restraints / parameters	4171 / 0 / 298
Goodness-of-fit on $F^2$	1.038
Final <i>R</i> indices [ <i>I</i> >2sigma( <i>I</i> )]	$R_1 = 0.0406, wR_2 = 0.1103$
R indices (all data)	$R_1 = 0.0453, wR_2 = 0.1146$
Largest diff. peak and hole (e.Å <sup>-3</sup> )	0.285 and -0.223

 Table 1S. Summary of X-ray single crystal diffraction refinement results for 3e.

	x	V	Z	$U_{\rm iso}^*/U_{\rm eq}$
N1	0.21375 (6)	0.63809 (17)	0.19670 (4)	0.0230 (2)
01	0.17875 (6)	0.40750 (15)	0.10828 (4)	0.0287 (2)
C1	0.13916 (8)	0.5172 (2)	0.15433 (5)	0.0253 (2)
C2	0.06474 (8)	0.6931 (2)	0.12756 (5)	0.0267 (2)
C3	0.03840 (8)	0.8714 (2)	0.16491 (5)	0.0248 (2)
C4	0.09069 (8)	0.8867 (2)	0.22471 (5)	0.0256 (2)
C5	0.17794 (7)	0.78327 (19)	0.23913 (5)	0.0223 (2)
C6	0.01980 (10)	0.6743 (3)	0.06960 (6)	0.0400 (3)
C7	-0.05331 (10)	0.8320 (3)	0.04839 (7)	0.0452 (4)
C8	-0.08060 (9)	1.0078 (3)	0.08517 (6)	0.0377 (3)
C9	-0.03530 (8)	1.0283 (2)	0.14297 (6)	0.0311 (3)
C10	0.26151 (8)	0.2645 (2)	0.13047 (5)	0.0255 (2)
C11	0.33939 (8)	0.4391 (2)	0.15364 (5)	0.0226 (2)
C12	0.31030(7)	0.63101 (19)	0.18691 (4)	0.0199 (2)
C13	0.37697 (8)	0.8051 (2)	0.20842 (5)	0.0224 (2)
C14	0.47168 (8)	0.7882 (2)	0.19727 (5)	0.0265 (2)
C15	0.50018 (8)	0.6015 (2)	0.16393 (5)	0.0297 (3)
C16	0.43391 (8)	0.4283 (2)	0.14223 (5)	0.0277 (2)
C17	0.28193 (10)	0.1062 (2)	0.07995 (6)	0.0330 (3)
C18	0.23168 (7)	0.7978 (2)	0.29997 (5)	0.0227 (2)
C19	0.29163 (8)	0.6131 (2)	0.32340 (5)	0.0254 (2)
C20	0.33734 (8)	0.6221 (2)	0.38174 (5)	0.0287 (3)
C21	0.32416 (9)	0.8139 (2)	0.41854 (5)	0.0302 (3)
C22	0.26370 (9)	0.9975 (2)	0.39517 (5)	0.0305 (3)
C23	0.21894 (8)	0.9919 (2)	0.33688 (5)	0.0273 (2)
C24	0.37368 (13)	0.8251 (3)	0.48164 (6)	0.0459 (4)
H1	0.1097 (13)	0.393 (3)	0.1790 (8)	
H4	0.0619 (13)	0.974 (3)	0.2550 (8)	
H6	0.0394 (13)	0.549 (3)	0.0448 (8)	
H7	-0.0833 (13)	0.818 (3)	0.0061 (8)	
H8	-0.1331 (13)	1.119 (3)	0.0707 (8)	
H9	-0.0539 (13)	1.156 (3)	0.1688 (8)	
H10	0.2425 (13)	0.164 (3)	0.1645 (8)	
H13	0.3577 (13)	0.940 (3)	0.2305 (8)	
H14	0.5178 (13)	0.908 (3)	0.2127 (8)	
H15	0.5656 (13)	0.590 (3)	0.1560 (8)	
H16	0.4533 (13)	0.294 (3)	0.1181 (8)	
H17A	0.2955 (13)	0.203 (3)	0.0457 (8)	
H17B	0.3384 (13)	0.002 (4)	0.0925 (8)	
H17C	0.2260 (13)	0.006 (3)	0.0674 (8)	
H19	0.3017 (13)	0.472 (4)	0.2980 (8)	
H20	0.3798 (13)	0.488 (3)	0.3969 (8)	
H22	0.2542 (13)	1.134 (3)	0.4198 (8)	
H23	0.1784 (13)	1.127 (3)	0.3219 (8)	
H24A	0.4124 (13)	0.969 (4)	0.4892 (8)	
H24B	0.4144 (14)	0.694 (4)	0.4905 (8)	
H24C	0.3257 (13)	0.835 (3)	0.5094 (8)	

Table 28. Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters  $(Å^2)$  for 3e.

Bond lengths			
N1—C12	1.4051 (13)	C10—C11	1.5097 (16)
N1—C5	1 4080 (14)	C10-C17	1 5112 (16)
N1—C1	1.4867 (14)	C11—C16	1.3891 (15)
01	1.3948 (14)	C11—C12	1.4103 (15)
01-C10	1 4463 (13)	C12-C13	1 3960 (15)
C1-C2	1 5054 (15)	C12 - C12	1 3916 (15)
$C^2 - C^6$	1.3031(13) 1 3843 (17)	C14— $C15$	1.3910(13) 1.3857(17)
$C^2 - C^3$	1 3961 (16)	C15-C16	1 3901 (18)
C3 - C9	1 3992 (16)	C18 - C19	1 3956 (16)
C3-C4	1 4558 (16)	C18 - C23	1 4032 (16)
C4-C5	1 3555 (15)	C19 - C20	1 3925 (16)
C5-C18	1 4838 (15)	$C_{20}$ $C_{21}$	1 3923 (18)
C6—C7	1 3921 (19)	$C_{21}$ $C_{22}$	1 3947 (19)
C7—C8	1.3921(19) 1.382(2)	C21 - C24	1 5068 (18)
C8 - C9	1.302(2) 1 3835(18)	$C^{22}$ $C^{23}$	1.3864(17)
Rond angles	1.5055 (10)	022 023	1.5001(17)
C12 - N1 - C5	124 65 (9)	C7 - C8 - C9 - C3	-0.1(2)
C12 - N1 - C1	119 63 (9)	$C^{2}-C^{3}-C^{9}-C^{8}$	-0.47(18)
$C_{5}$ N1 $-C_{1}$	119.05 (9)	$C_{4}$ $C_{3}$ $C_{9}$ $C_{8}$	$178 \ 37 \ (12)$
C1 - O1 - C10	111.64 (8)	$C_1 - C_1 $	-70.15(11)
01 - C1 - N1	111.01(0) 111.71(9)	C1 - O1 - C10 - C17	165 35 (10)
01-C1-C2	108 29 (9)	01 - C10 - C11 - C16	-133.98(11)
N1-C1-C2	100.29(9) 110.48(9)	$C_{13}$ $C_{12}$ $C_{11}$ $C_{10}$	119.63 (10)
C6-C2-C3	120.60(11)	N1-C12-C11	117.64 (9)
C6-C2-C1	120.00(11) 122.34(11)	C14-C13-C12	120.05(10)
$C_{3}$ $C_{2}$ $C_{1}$	116.96 (10)	C15-C14-C13	120.05(10) 120.46(11)
$C^{2}-C^{3}-C^{9}$	118.76 (11)	C14-C15-C16	119 66 (10)
$C^2 - C^3 - C^4$	117.91 (10)	$C_{11}$ $-C_{16}$ $-C_{15}$	120.94(11)
$C_{2} = C_{3} = C_{4}$	123 32 (11)	C19 - C18 - C23	120.94(11) 118.09(10)
$C_{5} - C_{4} - C_{3}$	123.52 (11)	C19 - C18 - C5	121.18(10)
C4-C5-N1	118 66 (10)	$C^{23}$ $-C^{18}$ $-C^{5}$	120.63(10)
C4-C5-C18	121 94 (10)	$C_{20}$ $C_{10}$ $C$	120.03(10) 120.74(11)
N1-C5-C18	119 08 (9)	$C_{21}$ $C_{20}$ $C_{19}$ $C$	121.21(11)
$C^2 - C^6 - C^7$	119.00 (5)	$C_{20}$ $C_{21}$ $C_{22}$ $C_{22}$	117 96 (11)
C8 - C7 - C6	119.93 (13)	$C_{20} - C_{21} - C_{24}$	121 47 (13)
C7 - C8 - C9	120.27(12)	$C_{22}$ $C_{21}$ $C_{24}$	120.57(13)
C8 - C9 - C3	120.27(12) 120.48(12)	$C_{23}$ $C_{22}$ $C_{21}$ $C_{21}$ $C_{21}$	120.37(13) 121.31(11)
01 - C10 - C11	105 64 (9)	$C^{22}$ $C^{23}$ $C^{18}$	120.68(11)
01 - C10 - C17	106.86 (9)	C17 - C10 - C11 - C16	-15.64 (16)
$C_{11} - C_{10} - C_{17}$	116.34 (10)	01-C10-C11-C12	43.00 (12)
C16—C11—C12	119.24 (10)	C17—C10—C11—C12	161.34 (10)
C16—C11—C10	124.90 (10)	C5—N1—C12—C13	-15.18 (16)
$C_{12}$ $-C_{11}$ $-C_{10}$	115.79 (9)	C1 - N1 - C12 - C13	154.39 (10)
C13 - C12 - N1	122,73 (9)	C5-N1-C12-C11	165 12 (10)
C10-01-C1-N1	48.75 (13)	C1 - N1 - C12 - C11	-25.30(14)
C10-01-C1-C2	170.64 (9)	C16-C11-C12-C13	-0.77 (15)
$C_{12} = N_{1} = C_{1} = 0_{1}$	0.09(14)	C10-C11-C12-C13	-177.94 (9)
C5-N1-C1-O1	170.64 (9)	C16-C11-C12-N1	178.94 (10)
$C_{12} = N_{1} = C_{1} = C_{2}$	-120.53 (11)	C10-C11-C12-N1	1.77 (14)
C5—N1—C1—C2	50.02 (13)	N1—C12—C13—C14	179.97 (10)
01-C1-C2-C6	22.92 (16)	C11—C12—C13—C14	-0.34 (16)
N1-C1-C2-C6	145.56 (12)	C12—C13—C14—C15	1.20 (17)
01-C1-C2-C3	-160.56 (10)	C13—C14—C15—C16	-0.93 (17)
N1-C1-C2-C3	-37.92 (14)	C12—C11—C16—C15	1.05 (17)
C6—C2—C3—C9	1.00 (18)	C10-C11-C16-C15	177.93 (11)
C1—C2—C3—C9	-175.58 (10)	C14—C15—C16—C11	-0.20 (18)
C6—C2—C3—C4	-177.90 (12)	C4—C5—C18—C19	148.00 (11)

Table 38. Geometric parameters (Å, °) for 3e.

C1—C2—C3—C4	5.51 (15)	N1—C5—C18—C19	-25.38 (15)
C2—C3—C4—C5	18.77 (17)	C4—C5—C18—C23	-28.10 (16)
C9—C3—C4—C5	-160.08 (12)	N1-C5-C18-C23	158.51 (10)
C3—C4—C5—N1	-6.52 (17)	C23—C18—C19—C20	0.00 (16)
C3—C4—C5—C18	-179.93 (10)	C5-C18-C19-C20	-176.20 (10)
C12—N1—C5—C4	141.11 (11)	C18—C19—C20—C21	0.50 (17)
C1—N1—C5—C4	-28.90 (15)	C19—C20—C21—C22	-0.06 (17)
C12—N1—C5—C18	-45.29 (15)	C19—C20—C21—C24	-179.79 (12)
C1—N1—C5—C18	144.70 (10)	C20—C21—C22—C23	-0.89 (17)
C3—C2—C6—C7	-0.9 (2)	C24—C21—C22—C23	178.84 (12)
C1—C2—C6—C7	175.47 (13)	C21—C22—C23—C18	1.41 (17)
C2—C6—C7—C8	0.3 (2)	C19—C18—C23—C22	-0.93 (16)
C6—C7—C8—C9	0.2 (2)	C5—C18—C23—C22	175.28 (10)









<sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>









S14

# $^{13}\text{C}$ NMR, 75 MHz, CDCl\_3











<sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>









<sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>











# <sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>







 $^{13}\text{C}$  NMR, 75 MHz, CDCl\_3





# $^{13}\text{C}$ NMR, 75 MHz, CDCl\_3





<sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>




<sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>









## <sup>1</sup>H NMR, 300 MHz, CDCl<sub>3</sub>







## <sup>13</sup>C NMR, 75 MHz, CDCl<sub>3</sub>



Data File C:\HPCHEM\1\DATA\JC76.D Sample Name: jc76 10ipa dea amy 2 \_\_\_\_\_\_\_ \_\_\_\_\_ Injection Date : 04/06/18 9.41.31 : jc76 10ipa dea Vial : 1 Sample Name Acq. Operator : 1 : C:\HPCHEM\1\METHODS\CECE.M Method TABLE3 Last changed ! : 04/06/18 9.34.42 by 1 Emiry 1 (modified after loading) DAD1 B, Sig=254,4 Ref=off (JC76.D) mAU 400 350 300 250 200 150 10.661 100 50 856 0 6 8 10 12 14 min Area Percent Report Sorted By Signal 1 adate. 1.0000 Multiplier : ..... 1.0000 Dilution : Signal 1: DAD1 B, Sig=254,4 Ref=off Peak RetTime Type Width Area Height Area 00 [min] [mAU\*s] [mAU] # [min] 17.231VV0.27147893.33594435.5696451.454528.856VV0.5236227.534705.400261.4832310.661VB1.41477219.5585972.9435747.0623 521. 72.94357 47.0623 48% Totals : 1.53404e4 513.91347 98.51 Results obtained with enhanced integrator! \*\*\* End of Report \*\*\*

Instrument 1 04/06/18 9.57.24 1

Page 1 of 1



Instrument 1 15/06/18 14.32.55 1

£.

Page 1 of 1

































Instrument 1 03/10/19 11.06.33 1

Page 1 of 1













S68










