Efficient Synthesis of 2-Alkylidene-3-iminoindoles, Indolo[1,2-*b*]isoquinolin-5-ones, *δ*-Carbolines, and Indirubines by Domino and Sequential Reactions of Functionalized Nitriles

Peter Langer,* Joachim T. Anders, Klaus Weisz, and Judith Jähnchen[a]

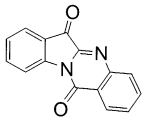
Abstract: The sodium hydride mediated cyclization of arylacetonitriles with oxalic acid bis(imidoyl) dichlorides, aza-analogues of oxalyl chloride, afforded functionalized 2-alkylidene-3-iminoindoles with very good regio- and *E*/*Z* selectivity. Excellent chemoselectivities were observed for functionalized substrates. Based on these results a domino "cyclization – lactamization" reaction of bis(imidoyl) chlorides with methyl 2-(cyanomethyl)benzoate was developed. This process allowed a convenient one-pot synthesis of indolo[1,2-*b*]isoquinolin-5-ones related to tryptanthrin. A new and convenient synthesis of *δ*-carbolines by intramolecular electrocyclization – elimination reactions of 2-alkylidene-3-iminoindoles was developed. It was shown that *δ*-carbolines selectively bind to triplex or duplex DNA (intercalation). Indirubine analogues were prepared by deprotection and lactonization of functionalized 2-alkylidene-3-iminoindoles.

Keywords: cyclization · DNA · domino reactions · imidoyl chlorides · nitriles

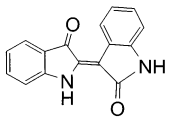
Introduction

2-Alkylidene-3-oxindoles represent important building blocks for the synthesis of alkaloids[1, 2] and non-natural target molecules.[3] We have recently reported[4] a versatile synthesis of 2-alkylidene-3-iminoindoles—masked 2-alkylidene-3-oxindoles—by cyclization of dilithiated nitriles and sulfones with oxalic acid bis(imidoyl) dichlorides.[5] Bis(imidoyl) dichlorides can be prepared in two steps from inexpensive anilines and can be regarded as aza-analogues of oxalyl chloride.[6] However, a problem associated with our methodology lies in the fact that generation of the dilithio compounds requires the use of a strong base (lithium diisopropylamide (LDA) or *n*BuLi).[7] Therefore, the synthesis of ester-, nitrile-, or halide-substituted indoles was not possible, due to nucleophilic attack of the dianion onto the nitrile and ester groups and metal – halide exchange, respectively.

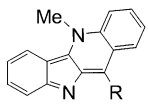
Herein, we report a new protocol that allows the synthesis of functionalized indoles with excellent chemoselectivity. Based on these results, a new domino process was developed:[8] The domino "cyclization – lactamization" reaction of methyl 2-(cyanomethyl)benzoate with bis(imidoyl) dichlorides allowed a convenient one-pot synthesis of cyano-substituted indolo[1,2-*b*]isoquinolin-5-ones. Although the parent heterocyclic core structure was first reported in 1940, functionalized derivatives are rare.[9a] Recent syntheses of unfunctionalized indolo[1,2-*b*]isoquinolin-5-ones include intramolecular Heck reactions of 2-alkylidene-3-oxindoles.[9e] Indolo[1,2-*b*]isoquinolin-5-ones are of considerable pharmacological relevance because they represent C-analogues of tryptanthrin.[10] Related structures occur, for example, in Goniometine-type alkaloids.[11]



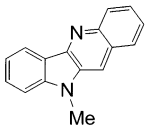
Tryptanthrin



Indirubine



Cryptolepine (R = H)
Hdroxycryptolpine (R = OH)



Cryptoquindoline

[a] Prof. Dr. P. Langer, Dipl.-Chem. J. T. Anders, Prof. Dr. K. Weisz, Dr. J. Jähnchen
Ernst-Moritz-Arndt-Universität Greifswald
Institut für Chemie und Biochemie Soldmannstrasse 16, 17487 Greifswald (Germany)
Fax: (+49) 3834-864373
E-mail: peter.langer@uni-greifswald.de

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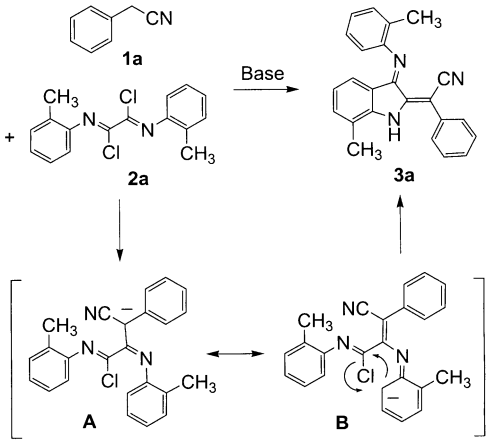
In addition, we report a new approach to δ-carbolines by sequential "cyclization–electrocyclization" reactions of nitriles with bis(imidoyl) dichlorides. These results show that 2-alkylidene-3-iminoindoles are useful synthetic building blocks. Carbolines have been prepared so far mainly by cycloaddition reactions and occur in a number of natural products.[12–14] Benzoannulated δ-carbolines, which are readily available by our methodology, are related to the antitumor agent ellipticin[15] and occur in a variety of antibiotically active natural products, such as cryptolepine, cryptoquindoline, biscryptolepine, and neocryptolepine.[16] Benzoannulated δ-carbolines are pharmacologically relevant systems, due to their potential cancerostatic activity. Herein, we report first results related to experiments that indicate that our δ-carbolines selectively bind to triplex or duplex DNA (intercalation). In these experiments a 35mer oligonucleotide, capable of forming both triple- and double-helical structures by folding, was used.

The synthetic utility of 2-alkylidene-3-iminoindoles was further demonstrated by the development of a new approach to indirubine analogues by sequential "cyclization–lactonization" reactions. The synthesis of indirubine analogues is of great current interest, due to the recently recognized antitumor activity of indirubine and indigo derivatives.[17]

Results and Discussion

Synthesis of functionalized 2-alkylidene-3-iminoindoles

Optimization: Our standard protocol[4a] for the synthesis of 2-alkylidene-3-iminoindoles relies on the use of dilithiated nitriles which are generated from two equivalents of strong base. These dianions reside in many cases as monoanions which are associated to one molecule of base (e.g. LDA).[7] Therefore, it was hoped that modification of the reaction conditions (employment of a weak base, stepwise deprotonation) would improve the applicability of our methodology to functionalized substrates. Variation of the reaction conditions was studied for the cyclization of phenylacetonitrile (**1a**) with oxalic acid bis(2-tolylimidoyl) dichloride (**2a**) (Scheme 1, Table 1). Employment of LDA resulted in the formation of indole **3a** in 53% yield with complete *E* diastereoselectivity.[4] The formation of **3a** can be explained by initial attack of the nitrile onto **2a** to give an ambident anionic intermediate. Stereoelectronically favored 5-*exo-trig* cyclization subsequently occurred from the *ortho*-carbon atom of the arylimino group and rearomatization led to the final product (Scheme 1). After much experimentation, we found that optimal yields of **3a** (up to 83%) were obtained when a solution of the starting materials in THF was refluxed in the presence of sodium hydride (NaH) for 72 h. The use of other solvents or bases proved less satisfactory (Table 1). No loss of diastereoselectivity was observed. This was not unexpected, since the *E*-configured isomer represents the thermodynamically favored product.



Scheme 1. Synthesis of indole **3a**.

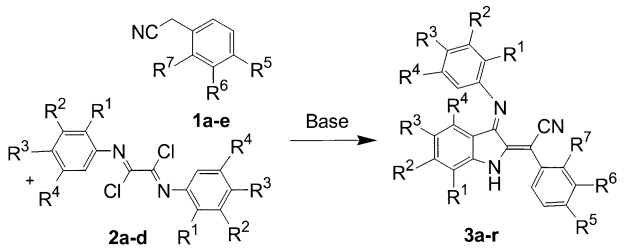
Table 1. Variation of the reaction conditions

Entry	Conditions				Yield [%][a]
	base (equiv)	solvent	temperature	time [h]	
1	LDA (2.3)	THF	$-100 \rightarrow 20\,^{\circ}C$	12	53
2	K_2CO_3(3.0)	THF	reflux	120	54
3	KO*t*Bu (3.0)	THF	reflux	120	20
4	K_2CO_3 (3.0)	DMF	reflux	24	14
5	NaH (3.0)	THF	reflux	24	40
6	NaH (3.0)	THF	reflux	72	83
7	NaH (3.0)	THF	$20\,^{\circ}C$	72	8
8	NaH (3.0)	THF	reflux	120	72

[a] Yield of **3a** isolated.

Preparative scope: The application of our new protocol to *functionalized* substrates was studied next (Scheme 2, Table 2). The LDA-mediated reaction of (4-bromophenyl)acetonitrile (**1b**) with **2a** afforded the bromo-substituted indole **3b**, however, in only 19% yield (due to extensive metal–halide exchange). In contrast, the use of NaH/THF resulted in a dramatic increase in yield (91%). The NaH-mediated

Abstract in German: *Die Natriumhydrid-vermittelte Cyclisierung von Arylacetonitrilen mit Oxalsäure-bis(imidoyl)dichloriden, Azaanaloga des Oxalylchlorids, liefert funktionalisierte 2-Alkyliden-3-iminoindole mit sehr guter Regio- und E/Z-Selektivität. Exzellente Chemoselektivitäten wurden für funktionalisierte Substrate beobachtet. Basierend auf diesen Resultaten wurde eine Domino "Cyclisierungs-Lactamisierungs"-Reaktion von Bis(imidoyl)dichloriden mit Methyl 2-(Cyanomethyl)benzoat entwickelt. Diese Reaktion ermöglicht eine bequeme Ein-Topf-Synthese von Indolo[1,2-b]isoquinolin-5-onen, die strukturell dem Tryptanthrin verwandt sind. Weiterhin wird ein neuartiger und effizienter Zugang zu δ-Carbolinen durch intramolekulare "Elektrocyclisierungs-Eliminierungs"-Reaktionen von 2-Alkyliden-3-iminoindolen vorgestellt. Die δ-Carboline binden selektiv and Triplex oder Duplex DNA durch Intercalation. Schließlich wurde ein neuer Zugang zu Indirubin-Analoga durch Entschützung und Lactonisierung geeigneter funktionalisierter 2-Alkyliden-3-iminoindole entwickelt.*



Scheme 2. Synthesis of 2-alkylidene-3-iminoindoles **3**.

Table 2. Synthesis of 2-alkylidene-3-iminoindoles **3a–r**.

1	2	3	Base	R^1	R^2	R^3	R^4	R^5	R^6	R^7	[%][a]	λ_{max}[b]
b	**a**	**b**	LDA	Me	H	H	H	Br	H	H	19	
b	**a**	**b**	NaH	Me	H	H	H	Br	H	H	91	461
b	**b**	**c**	NaH	H	H	H	H	Br	H	H	95	461
b	**c**	**d**	NaH	H	Me	H	H	Br	H	H	61	459
c	**a**	**e**	K_2CO_3	Me	H	H	H	H	Br	H	49	461
c	**a**	**e**	NaH	Me	H	H	H	H	Br	H	84	
d	**b**	**f**	LDA	H	H	H	H	H	H	CN	0	
d	**b**	**f**	NaH	H	H	H	H	H	H	CN	61	480
d	**a**	**g**	K_2CO_3	Me	H	H	H	H	H	CN	40	461
e	**a**	**h**	LDA	Me	H	H	H	CO_2Me	H	H	0	467
e	**a**	**h**	NaH	Me	H	H	H	CO_2Me	H	H	48	
a	**d**	**i**	*n*BuLi	H	Br	H	H	H	H	H	8	461
a	**d**	**i**	NaH	H	Br	H	H	H	H	H	44	
f	**b**	**j**	LDA	H	H	H	H	H	H	OMe	55	465
f	**a**	**k**	LDA	Me	H	H	H	H	H	OMe	51	462
f	**c**	**l**	LDA	H	Me	H	H	H	H	OMe	71	462
f	**e**	**m**	LDA	Me	H	Me	H	H	H	OMe	62	475
g	**f**	**n**	NaH	H	H	Me	H	H	OMe	H	60	481
h	**a**	**o**	*n*BuLi	Me	H	H	H	OMe	H	H	30	470
i	**b**	**p**	LDA	H	H	H	H	H	H	Me	74	459
j	**f**	**q**	*n*BuLi	H	H	Me	H	H	Me	H	62	481
k	**g**	**r**	NaH	H	Me	H	Me	Me	H	H	96	481

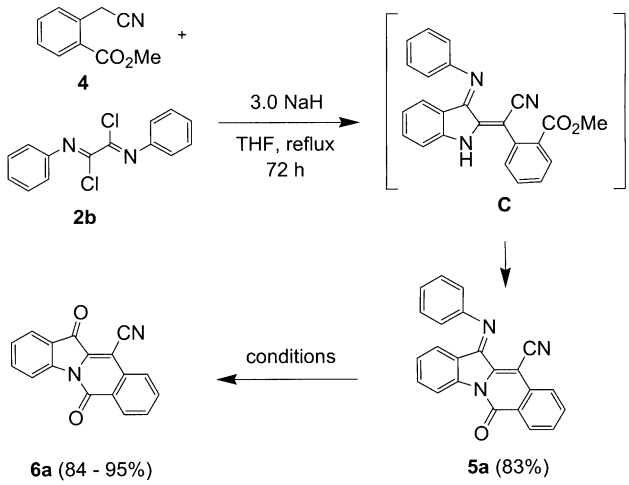
[a] Yield of isolated product. [b] UV/Vis [nm] ($CHCl_3$).

syntheses of the bromo-substituted indoles **3c** and **3d** were equally successful. The reaction of (3-bromophenyl)acetonitrile (**1c**) with **2a** in the presence of K_2CO_3 afforded indole **3e** in 49% yield. The use of NaH again resulted in a dramatic increase in yield (84%).

Deprotonation of (2-cyanophenyl)acetonitrile (**1d**) with LDA has been reported to result in dimerization by intermolecular attack of the carbanion onto the nitrile.[18] It was therefore not unexpected that treatment of **1d** with LDA and subsequent addition of **2b** resulted in the formation of a complex mixture. In contrast, the cyano-substituted indoles **3f** and **3g** were formed in good yields when NaH and K_2CO_3 were employed, respectively. The LDA-mediated reaction of methyl 4-(cyanomethyl)benzoate (**1e**) with oxalic acid bis(imidoyl) dichloride **2a** was unsuccessful. In contrast, the desired indole **3h** could be prepared in good yield by using NaH. The NaH-mediated cyclization of **1a** with oxalic acid bis(*m*-bromophenylimidoyl) dichloride (**2d**) afforded **3i** containing a bromo-substituted indole moiety (44%). In contrast, the product was formed in only 8% yield when *n*-butyllithium was employed. Although reactions of *meta*-substituted bis(imidoyl) chlorides can, in principle, result in formation of regioisomers, indole **3i** was formed with very good regioselectivity. The novel 2-alkylidene-3-iminoindoles **3j–r** were prepared by use of strong base (except for **3n** and **3r**). The synthesis of all indoles **3a–r** proceeded with excellent *E* diastereoselectivity ($E/Z > 98:2$).

Synthesis of indolo[1,2-*b*]isoquinolin-5-ones by domino "cyclization–lactamization" reactions

Optimization: Based on the results outlined above, a novel domino process was developed. The NaH-mediated reaction of methyl 2-(cyanomethyl)benzoate (**4**) with bis(imidoyl) chloride **2a** afforded 5,11-dihydro-indolo[1,2-*b*]isoquinolin-5-one (**5a**) in only one step by a domino "cyclization–lactamization" reaction via intermediate **C** (Scheme 3). The cleavage



Scheme 3. Domino "cyclization–lactamization" reactions of **2b** with **4**. Conditions: 1) DMSO, reflux, 16 h, 84%; or 2) THF/HCl (10%) = 1:1, 20 °C, 72 h, 95%.

of the imino group was studied next. After some experimentation we found that treatment of **5a** with a 1:1 mixture of THF and an aqueous solution of HCl (10%) afforded the desired parent ketone **6a** in 95% yield. Interestingly, simple reflux of a solution of **5a** in DMSO also resulted in the formation of **6a** in high yield. This reaction was monitored by ^1H NMR spectroscopy ($[D_6]$DMSO). The NMR spectrum of the crude mixture exclusively showed the signals of **6a**. No formation of aniline or azobenzene was detected. However, a very broad signal in the aromatic region was observed which suggested that polyaniline was formed. Since no water was added to the reaction mixture at any time, the oxygen atom of **6a** could have derived from DMSO. In fact, the formation of dimethyl sulfide was detected by its characteristic smell. However, the DMSO-mediated cleavage of imines has, to the best of our knowledge, not been previously reported.[19] Alternatively, the formation of **6a** can be explained by hydrolysis of **5a** by small amounts of water present in DMSO.

Preparative scope: The domino cyclizations of **4** with other bis(imidoyl) chlorides were equally successful and afforded indolo[1,2-*b*]isoquinolin-5-ones **5b–g** in 55–96% yields (Table 3). The cyclization of **4** with **2c** resulted in formation of a

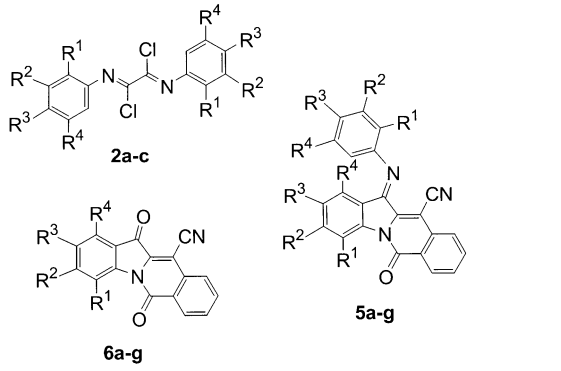


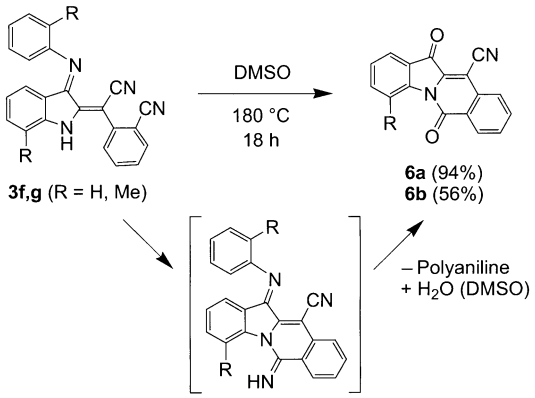
Table 3. Synthesis of the indolo[1,2-*b*]isoquinolin-5-ones **5** and **6**.

2	**5, 6**	R^1	R^2	R^3	R^4	Yield **5** [%][a]	λ_{max}[c]	Yield **6** [%][a]	λ_{max}[c]
a	**a**	H	H	H	H	83	423	84 (95)	419
b	**b**	Me	H	H	H	50	426	48 (82)	423
c	**c**	H	Me	H	H	55[b]	420	–	–
c	**d**	H	H	H	Me	55[b]	420	–	–
f	**e**	H	H	Me	H	85	431	94 (100)	426
g	**f**	H	Me	H	Me	96	457	48 (84)	449
h	**g**	H	H	MeO	H	87	–	67 (90)	–

[a] Yield of isolated product. For compounds **6**: yields obtained by reflux of a solution of **5 in** DMSO; in parentheses: yields obtained by treatment of **5** with HCl (10%). [b] Mixture of regioisomers (**5c**/**5d** = 2.4:1, **5c** + **5d** = 55%). [c] UV/Vis [nm] ($CHCl_3$).

mixture of regioisomers. The cleavage of the imino group of **5b** and **5e**–**g** afforded the parent indolo[1,2-*b*]isoquinolin-5-ones **6b** and **6e**–**g** in good yields. Better yields were generally obtained by using HCl/THF/20 °C rather than by refluxing a solution of the starting materials in DMSO.

We also developed an alternative approach to parent indolo[1,2-*b*]isoquinolin-5-ones **6.** Reflux of a solution of 2-alkylidene-3-iminoindoles **3f** and **3g** in DMSO directly afforded **6a** and **6b**, respectively (Scheme 4). The formation



Scheme 4. Synthesis of indolo[1,2-*b*]isoquinolin-5-ones **6a**, **b** from **3f**, **g**.

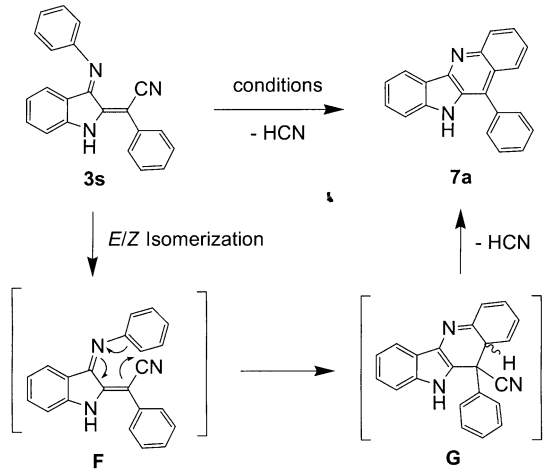
of these products can be explained by intramolecular attack of the indole nitrogen atom onto the nitrile to give an amidine, cleavage of the imino group (vide supra), and hydrolysis of the imine during chromatography or by water present in DMSO. The yields of **6a** and **6b** (over two steps from bis(imidoyl) dichlorides **2b** and **2a**) were 57% and 23%, respectively. The overall yields of those products prepared via **5a** and **5b** were 70% and 24%, respectively. Therefore, the latter approach was more efficient in terms of yield.

All indoles prepared have been compared with regard to their UV/Vis absorption properties. Simple unsubstituted indoles such as **3a** showed λ_{max} values around 460 nm. The presence of one (**3b**–**e**) or more (**3i**) halide atoms did not have any significant effect on the λ_{max} absorptions. In contrast, the presence of an ester group (**3h**) led to a slightly increased λ_{max} value (467 nm). Hypsochromic shifts were observed for indolo[1,2-*b*]isoquinolin-5-ones **5a**–**g** (λ_{max} = 420–457 nm) with respect to the corresponding 2-alkylidene-3-iminoindoles **3**. This observation can be explained by replacement of the free NH group by an electron-withdrawing lactam moiety which results in a less pronounced *push*–*pull* character of the indigo-type chromophore. The absence of the arylimino group in heterocycles **6** resulted only in a slight hypsochromic effect. For reasons of comparison, measurements have been carried out in DMF and $CHCl_3$: a bathochromic shift of the λ_{max} absorptions was generally observed for measurements in DMF with respect to $CHCl_3$ (+6 to +20 nm).

Synthesis of δ-carbolines by sequential "cyclization–electrocyclization" reactions

Optimization: 2-Alkylidene-3-iminoindoles **3** represent not only masked 2-alkylidene-3-oxindoles, but also potential starting materials for the synthesis of δ-carbolines. We found that δ-carbolines can be prepared from **3** by 6π electrocyclization (involving the exocyclic double bond and the arylimino group of the indole) and subsequent elimination of HCN. This type of reaction has to our knowledge not yet been reported.[20] However, our initial experiments to realize this transformation were unsuccessful: Treatment of indole **3s**[4a] with TFA or TfOH (neat) or with concentrated aqueous solutions of HCl or NaOH resulted in decomposition. Only starting material was recovered by use of more dilute solutions (CH_2Cl_2 or H_2O). Flash vacuum pyrolysis (FVP) of **3s** afforded the desired δ-carboline **7a**, however, in only 12% yield. Only starting material was recovered when a solution of **3s** in THF was refluxed for 48 h. We eventually found that optimal yields of **7a** were obtained when a solution of **3s** in DMSO was refluxed for 48 h (Scheme 5, Table 4). The use of other solvents was less effective. Prolongation of the reaction time did not result in an increase of the yield.

Preparative scope: To study the preparative scope of the novel electrocyclization–elimination reaction, the substituents of 2-alkylidene-3-iminoindoles **3** were systematically varied (Scheme 6, Table 5). A number of δ-carbolines (**7b**–**i**), containing methyl and methoxy groups at various positions, were prepared from the corresponding indoles in up to 80% yield. δ-Carbolines **7j**–**l**, containing bromo and ester groups, were prepared from the corresponding functionalized indoles with very good chemoselectivity. In case of **7j**, 2-alkylidene-3-oxindole **8** was isolated as a second product in 49% yield. This

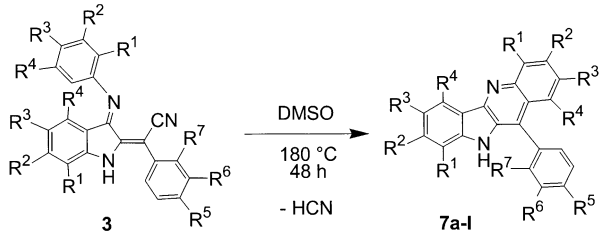


Scheme 5. Synthesis of δ-carboline **7a**.

Table 4. Variation of the reaction conditions.

Entry	Conditions[a]	Yield [%][b]
1	FVP, 450 °C	12
2	THF, reflux, 48 h	0
3	DMSO, reflux, 48 h	61
4	DMSO, reflux, 24 h	30
5	DMSO, reflux, 130 h	50
6	DMSO, 70 °C, 48 h	0
7	DMF, reflux, 48 h	0
8	toluene, reflux, 48 h	0

[a] FVP = flash vacuum pyrolysis . [b] Yield of **7a** isolated.

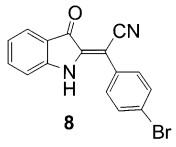


Scheme 6. Synthesis of δ-carbolines **7a–l**.

Table 5. Synthesis of δ-carbolines **7a–l**.

3	7	R^1	R^2	R^3	R^4	R^5	R^6	R^7	Yield [%][a]	$F\ \lambda_{max}$[c]
s	**a**	H	H	H	H	H	H	H	61	429
a	**b**	Me	H	H	H	H	H	H	37	429
t	**c**	H	H	Me	H	H	H	H	55	439
q	**d**	H	H	Me	H	H	Me	H	63	–
u	**e**	Me	H	Me	H	H	H	H	76	448
r	**f**	H	Me	H	Me	Me	H	H	80	444
o	**g**	Me	H	H	H	OMe	H	H	71	427
n	**h**	H	H	Me	H	H	OMe	H	32	–
v	**i**	OMe	H	H	H	H	H	H	77	553
c	**j**	H	H	H	H	Br	H	H	48[b]	429
b	**k**	Me	H	H	H	Br	H	H	71	434
h	**l**	Me	H	H	H	CO_2Me	H	H	38	–

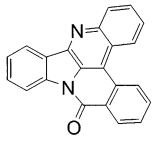
[a] Yield of isolated product. [b] A second product (**8**) was also isolated in 49% yield. [c] Fluorescence [nm] (CH_3CN).



observation corresponds to the formation of indolo[1,2-*b*]-isoquinolin-5-ones **6** from imino derivatives **5**. All δ-carbolines **7a–l** were isolated in moderate to good yields and are available in only two steps from readily available and inexpensive starting materials. Due to the use of symmetric oxalic acid bis(imidoyl) dichlorides, our methodology is limited so far to the synthesis of δ-carbolines containing substitution patterns as depicted in Scheme 6. Future plans are directed towards employment of *unsymmetrical* bis(imidoyl) dichlorides to install substituents at all positions of the δ-carboline moiety independently from each other.

Carbolines **7** are of special interest because they are fluorescence dyes. Emission in the range of 429–448 nm is observed for alkyl- and bromo-substituted derivatives. No shift of the emission wavelength was observed for the presence of a methoxy group at the phenyl group. In contrast, a dramatic bathochromic shift was observed for **7i**, which contains a methoxy group located at the indole moiety (553 nm).

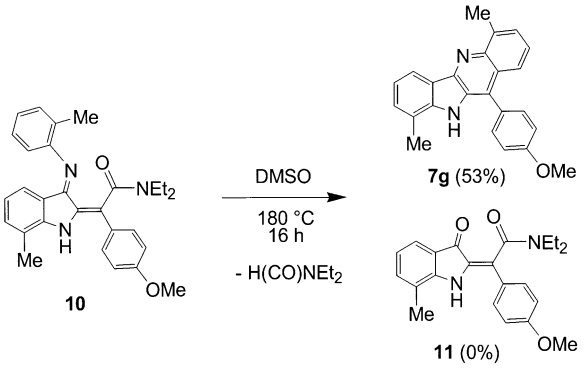
Mechanistic considerations: Indolo[1,2-*b*]isoquinolin-5-ones **5** can be regarded as lactam-bridged 2-alkylidene-3-iminoindoles. Different thermolytic reaction pathways were observed for bridged and unbridged 2-alkylidene-3-iminoindoles **5** and **3**. Thermolysis of **5b** resulted in the formation of **6b** (vide supra) rather than pentacyclic δ-carboline **9**. This can be



explained in two ways: a) Formation of an sp^3-hybridized carbon atom is required for electrocyclization (intermediate **G**; see Scheme 5). The corresponding intermediate leading to **9** would suffer from severe allylic strain; b) twisting of the triene system is necessary for optimal orbital overlap during electrocyclization. This twisting is more difficult for bridged heterocycles **5** than for **3**.

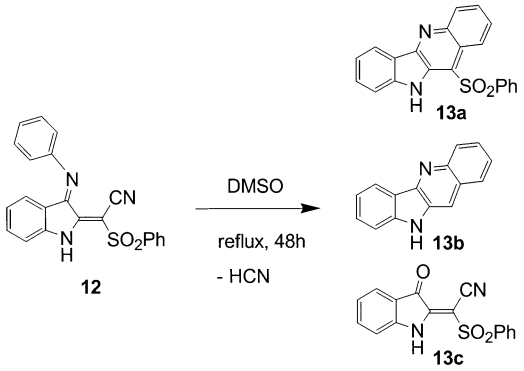
The thermolysis of amide **10**[4b] was studied next (Scheme 7). In this substrate the excellent leaving group cyanide was replaced by a poor leaving group. Reflux of a solution of **10** in DMSO resulted in the formation of δ-carboline **7g** (53%). The formation of 2-alkylidene-3-oxindole **11** could not be detected. Although **7g** could be prepared from nitrile **3o** in better yield than from **10** (71%, Table 5), the product distribution seems not to be influenced by the leaving group ability.

Mainly decomposition was observed during the thermolysis of sulfone-substituted indole **12**. Small amounts (< 10%) each



Scheme 7. Thermolysis of amide **10**.

of δ-carbolines **13a** and **13b** (the latter formed by extrusion of the sulfone group of **13a**), and of 2-alkylidene-3-oxindole **13c** were detected (Scheme 8). This result shows that the product distribution is influenced by the substitution pattern and electronic situation of the substrate.



Scheme 8. Thermolysis of 2-alkylidene-3-oxindole **12**.

DNA intercalation experiments: Several polycyclic compounds have been shown in the past to selectively bind to triplex or duplex DNA resulting in significant stabilization of such structures. Thus, favored by its large aromatic ring system, benzo[*e*]pyridoindole significantly stabilizes triplex DNA by intercalation.[21] Likewise, based on their crescent-shaped geometry, indolo[1,2-*b*]isoquinolin-5-ones **6** and δ-carbolines **7** should experience extensive overlap with adjacent base triplets upon intercalation within DNA. Herein, we report first results related to these experiments: Using a 35mer oligonucleotide of the sequence GAAA-GAAGCGTTTTCGCTTCTTTCTTTTCTTTCTT, which is capable of forming both triple and double-helical structures by folding back on itself under suitable conditions (Figure 1), potential interactions with δ-carbolines **7a–l** were studied by UV melting experiments.[22]

The best results so far were obtained by using the ester-substituted δ-carboline **7l** (Figure 2). Other derivatives proved less successful, due to their low water solubility. As seen in Figure 2, two thermal transitions are generally observed in the UV melting curves at pH 7. The low-temperature transition corresponds to the melting of the triplex with

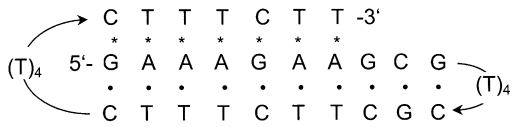


Figure 1. Folding of a 35-base oligodeoxynucleotide into an intramolecular triplex structure with ten Watson–Crick base pairs (·) and seven Hoogsteen bound third strand bases (∗)

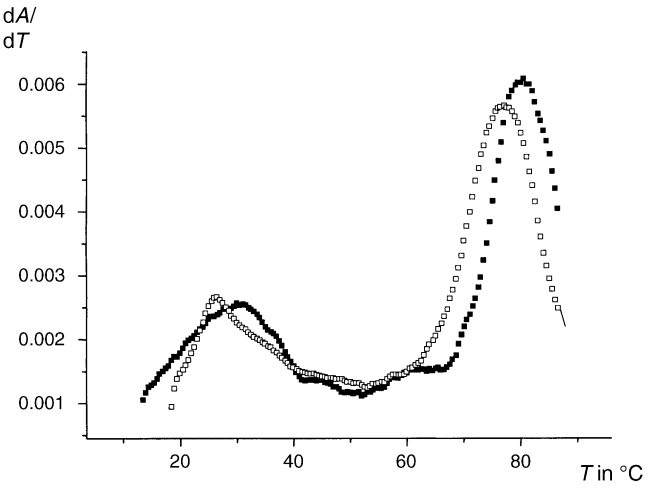


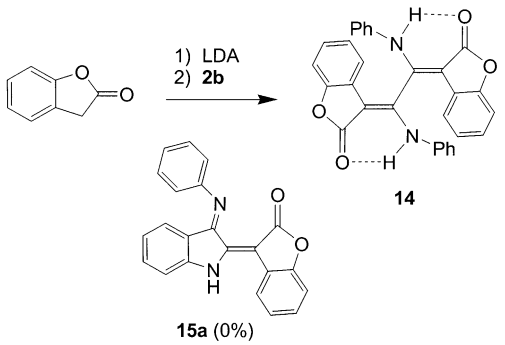
Figure 2. Plot of first derivative d*A*/d*T* versus temperature of the UV melting curves for the foldback triplex without (□) and with (■) δ-carboline **7l**.

dissociation of the "third" strand, whereas the high-temperature transition is associated with melting of the duplex stem. Upon adding a small amount of δ-carboline **7l** to the oligonucleotide, the triplex transition broadens but at the same time the melting temperature determined from the maximum of the first derivative plot d*A*/d*T* is shifted by about 4 °C to higher temperatures ($T_m \sim 29$ °C). It should be noted, that the low solubility of **7l** in aqueous solution prohibits larger effects on melting. A corresponding, yet smaller shift of about 2.6 °C is also observed for the duplex melting temperature in the presence of the heterocyclic compound. This indicates a stabilization of both the triplex and, albeit to a minor extent, of the duplex structure by the polycyclic ligand **7l**. Based on our encouraging initial results, future work is directed to the preparation of δ-carbolines that exhibit a better solubility in water (e.g. carboxylic acid derivatives) and to the synthesis of oligonucleotides containing a δ-carboline side chain for NMR experiments.

Synthesis of indirubine analogues by sequential "cyclization–lactonization" reactions

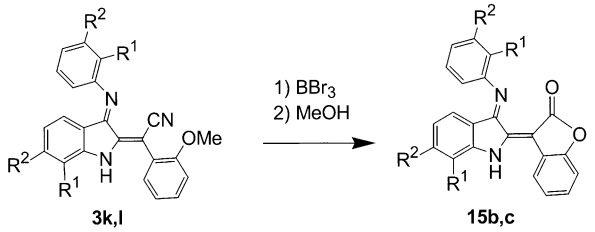
Our first attempts to prepare indirubine analogues by our methodology failed. The direct cyclization of 2-cumaranone with oxalic acid bis(phenylimidoyl)dichloride (**2b**) afforded the open-chain 2:1 condensation product **14** rather than indirubine derivative **15a** (Scheme 9). Therefore, we envisaged a sequential synthesis with employment of our methodology in the first step.

Methoxy-substituted 2-alkylidene-3-iminoindoles **3k,l** were prepared in good yields by cyclization of (2-methoxyphen-



Scheme 9. Reaction of 2-cumaranone with **2b**.

yl)acetonitrile (**1f**) with bis(imidoyl) dichlorides **2c,e** (Table 2). Treatment of indoles **3k,l** with BBr_3/MeOH resulted in deprotection and subsequent lactonization to give the desired products **15b,c** (Scheme 10).



Scheme 10. Synthesis of indirubine analogues: **15b**: $R^1 = Me$, $R^2 = H$: 53%, **15c**: $R^1 = H$, $R^2 = Me$: 33%.

Conclusions

The NaH-mediated cyclization of arylacetonitriles with oxalic acid bis(imidoyl) dichlorides allowed the synthesis of a great variety of functionalized 2-alkylidene-3-iminoindoles. The reactions are easy to carry out and the starting materials are readily available. The cyclizations proceeded with excellent chemo-, regio- and *E*/*Z* selectivity. Based on these results a new domino process was developed: The domino "cyclization–lactamization" reaction of methyl 2-(cyanomethyl)benzoate with bis(imidoyl) dichlorides allowed a convenient one-pot synthesis of indolo[1,2-*b*]isoquinolin-5-ones related to tryptanthrin. The hydrolytic cleavage of the arylimino group provided an efficient synthesis of the parent heterocycles. Thermolysis of 2-alkylidene-3-iminoindoles resulted in a novel electrocyclization–elimination reaction which provided a new and convenient approach to δ-carbolines. These compounds intercalate within DNA. Indirubine analogues were prepared by deprotection and lactonization of functionalized 2-alkylidene-3-iminoindoles. Indolo[1,2-*b*]isoquinolin-5-ones, δ-carbolines, and indirubine analogues are of great pharmacological relevance, due to their antibiotic and cytotoxic activity, and occur in a variety of natural products.

Experimental Section

General comments: All solvents were dried by standard methods and all reactions were carried out under an inert atmosphere. The oxalic acid bis(imidoyl) dichlorides **2** were prepared according to reference [9]. For the ^1H and ^{13}C NMR spectra (^1H NMR: 200, 300 and 500 MHz, ^{13}C NMR: 50, 75 and 125 MHz) the deuterated solvents indicated were used. Mass spectral data (MS) were obtained by using the electron ionization (70 eV), the chemical ionization (CI, H_2O), or the electrospray ionization technique (ESI). For preparative scale chromatography silica gel (60–200 mesh) was used. Melting points are uncorrected. Elemental analyses were performed at the microanalytical laboratory of the University of Göttingen.

Procedures for the synthesis of (*E*)-2-(1-cyano-1-phenylmethylidene)-7-methyl-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (3a)

Procedure 1 (use of LDA): *n*-Butyllithium (6.5 mL, 1.54 M solution in *n*-hexane, 10 mmol) was added to a solution of diisopropylamine (1.012 g, 10 mmol) in THF (30 mL) at 0 °C and the solution was stirred for 20 min. Phenylacetonitrile **1a** (0.469 g, 4.00 mmol) was added at 0 °C and the solution was stirred for 60 min. The solution was slowly transferred by cannula to a solution of oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 1.220 g, 4.00 mmol) in THF (50 mL) at −78 °C. The solution was warmed to 20 °C, stirred for 3 h, and poured into an aqueous solution of NH_4Cl (250 mL, 1 M). The organic and the aqueous layer were separated and the latter was extracted with diethyl ether (3 × 100 mL). The combined organic layers were dried ($MgSO_4$), filtered, and the filtrate was concentrated in vacuo. Chromatographic purification of the residue (silica gel; diethyl ether/petroleum ether = 1:3 → 1:1 → 3:1) afforded **3a** as a red solid (742 mg, 53%, *E*/*Z* > 98:2); ^1H NMR (250 MHz, $CDCl_3$): $\delta = 2.18$ (s, 3H; ArCH_3), 2.25 (s, 3H; ArCH_3), 6.50–6.63 (m, 2H; Ar), 6.88 (dd, $J = 7.7$ Hz, $J = 1.1$ Hz, 1H; Ar), 7.07–7.14 (m, 3H; Ar, NH), 7.20 (dd, $J = 7.6$ Hz, $J = 1.4$ Hz, 1H; Ar), 7.24–7.27 (m, 1H; Ar), 7.30–7.44 (m, 1H; Ar), 7.54 (ddd, $J = 7.9$ Hz, $J = 7.8$ Hz, $J = 1.5$ Hz, 2H; Ar), 7.70 ppm (dd, $J = 7.8$ Hz, $J = 1.4$ Hz, 2H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 15.71$ (ArCH_3), 17.97 (ArCH_3), 86.43 (*C*-CN), 116.97 (CH), 118.18, 119.05, 119.53 (C), 121.42, 123.96, 124.52, 126.53 (CH), 126.92 (C), 128.41, 128.59, 129.66, 130.75 (CH), 133.93 (C), 134.22 (CH), 146.02, 147.00, 149.18, 156.31 ppm (C); IR (KBr): $\tilde{\nu} = 3058$ (w, Ar-H), 2924 (m, C-H), 2851 (w), 2200 (m, C≡N), 1652 (s), 1617 (s), 1596 (s), 1583 (s), 1491 (m), 1457 (m), 1337 (m), 1223 (s), 1183 (m), 1111 (w), 1037 (w), 749 cm^{-1} (s); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 460.0 nm (3.95), 283.2 (4.24), 260.5 (4.19); MS (EI, 70 eV): *m*/*z* (%): 348 ($[M]^+$, 100), 322 (4), 256 (4); elemental analysis calcd (%) for $C_{24}H_{19}N_3$ (349.4): C 82.49, H 5.48, N 12.03; found: C 82.22, H 5.61, N 12.13.

Procedure 2 (use of potassium carbonate): A solution of phenylacetonitrile (**1a**; 0.359 g, 3.06 mmol), oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.934 g, 3.06 mmol), and potassium carbonate (1.269 g, 9.18 mmol) in THF (100 mL) was refluxed for five days under nitrogen. Chromatographic purification (silica gel; diethyl ether/petroleum ether = 1:3 → 1:1 → 3:1) afforded **3a** as a red solid (582 mg, 54%, *E*/*Z* > 98:2); elemental analysis calcd (%) for $C_{24}H_{19}N_3$ (349.4): C 82.49, H 5.48, N 12.03; found: C 82.24, H 5.68, N 12.07.

Procedure 3 (use of sodium hydride): A solution of phenylacetonitrile (**1a**; 0.117 g, 1.00 mmol), oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol), and sodium hydride (0.072 g, 3.00 mmol) in THF (50 mL) was refluxed for 3 d under nitrogen. Chromatographic purification (silica gel; diethyl ether/petroleum ether = 1:3 → 1:1 → 3:1) afforded **3a** as a red solid (291 mg, 83%, *E*/*Z* > 98:2); elemental analysis calcd (%) for $C_{24}H_{19}N_3$ (349.4): C 82.49, H 5.48, N 12.03; found: C 82.37, H 5.51, N 12.14.

(*E*)-2-[1-Cyano-1-(4-bromophenyl)methylidene]-7-methyl-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (3b): The reaction (procedure 3) of 4-bromophenylacetonitrile (**1b**; 0.196 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3b** as an orange solid (390 mg, 91%, *E*/*Z* > 98:2); ^1H NMR (250 MHz, $CDCl_3$): $\delta = 2.19$ (s, 3H; ArCH_3), 2.23 (s, 3H; ArCH_3), 6.50–6.64 (m, 2H; Ar), 6.86 (d, $J = 7.6$ Hz, 1H; Ar), 7.07–7.30 (m, 5H; Ar, NH), 7.61 ppm (2 × d, AA′XX′, 4H; Ar); ^{13}C NMR (50.3 MHz, [D$_6$]acetone): $\delta = 16.28$ (ArCH_3), 17.96 (ArCH_3), 85.87 (*C*-CN), 117.62 (CH), 118.78, 119.50 (C), 121.99 (CH), 122.15, 122.42 (C), 124.04, 125.22 (CH), 127.10 (C), 127.58, 131.55, 131.85, 133.18 (CH), 134.53 (C), 135.65 (CH), 148.26, 148.60, 150.41, 157.60 ppm (C); IR (KBr): $\tilde{\nu} = 3061$ (w, Ar-H), 3011 (w), 2968 (w), 2922 (w, C−H), 2860 (s), 2198 (m, C≡N), 1644 (m), 1618 (m), 1588 (s), 1485 (s), 1458 (m), 1339 (s), 1221 (s), 1184 (m), 1110 (w), 1077 (m), 1009 (m), 792 (w), 747 (s), 721 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 461.5 nm (4.06), 287.5 (4.25), 260.9 (4.32); MS (EI, 70 eV): *m*/*z* (%): 428 ($[M]^+$, 100), 348 (40), 256 (4); elemental analysis calcd (%) for $C_{24}H_{18}N_3Br$ (428.3): C 67.30, H 4.24, N 9.81; found: C 67.10, H 4.47,

N 9.73. The reaction (procedure 1) of **1b** (0.196 g, 1.00 mmol) and **2a** (0.305 g, 1.00 mmol) afforded **3b** as an orange solid (80 mg, 19%, $E/Z >$ 98:2); elemental analysis calcd (%) for $C_{24}H_{18}N_3Br$ (428.3): C 67.30, H 4.24, N 9.81; found: C 67.17, H 4.29, N 9.67.

(*E*)-2-[1-Cyano-1-(4-bromophenyl)methylidene]-3-phenylimino-2,3-dihydro-1*H*-indole (3c): The reaction (procedure 3) of 4-bromophenylacetonitrile (**1b**; 0.196 g, 1.00 mmol) and oxalic acid bis(phenylimidoyl) dichloride (**2b**; 0.277 g, 1.00 mmol) afforded **3c** as a red solid (380 mg, 95%, $E/Z >$ 98:2); ^{1}H NMR (300 MHz, [D$_6$]DMSO): $\delta = 6.42$ (d, 1H; Ar), 6.63 (t, 1H; Ar), 6.95–7.07 (m, 2H; Ar), 7.20–7.35 (m, 2H; Ar), 7.44–7.76 ppm (m, 8H; Ar, NH); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO): $\delta = 82.85$ (*C*-CN), 111.96 (CH), 119.87 (C), 117.59 (CH), 119.08 (C), 120.44 (CH), 121.21 (C), 124.39, 125.50, 129.52, 130.89, 132.07 (CH), 132.82 (C), 133.84 (CH), 147.01, 148.98, 150.41, 157.41 ppm (C); IR (KBr): $\tilde{\nu} = 3047$ (m, Ar-H), 2807 (m), 2192 (m, C≡N), 1638 (m), 1618 (m), 1579 (s), 1482 (m), 1464 (s),1403 (s), 1346 (s), 1219 (m), 1147 (w), 1094 (w), 828 (w), 750 (w), 693 cm^{-1} (m); UV/Vis (DMF): λ_{max} (lg ε) = 481.6 nm (3.89), 320.7 (3.73); UV/Vis ($CHCl_3$): λ_{max} = 461.1 nm; MS (EI, 70 eV): *m*/*z* (%): 400 ([*M*]$^+$, 100), 320 (55), 243 (10); elemental analysis calcd (%) for $C_{22}H_{14}N_3Br$ (400.3): C 66.01, H 3.53; found: C 66.24, H 4.28.

(*E*)-2-[1-Cyano-1-(4-bromophenyl)methylidene]-6-methyl-3-(3-tolyl)imino-2,3-dihydro-1*H*-indole (3d): The reaction (procedure 3) of 4-bromophenylacetonitrile (**1b**; 0.196 g, 1.00 mmol) and oxalic acid bis(3-tolylimidoyl) dichloride (**2c**; 0.305 g, 1.00 mmol) afforded **3d** as an orange solid (259 mg, 61%, $E/Z >$ 98:2). Only one regioisomer was selectively formed. ^{1}H NMR (300 MHz, [D$_6$]DMSO): $\delta = 2.26$ (s, 3H; ArC*H*$_3$), 2.38 (s, 3H; ArC*H*$_3$), 6.32–6.60 (m, 2H; Ar), 6.80 (s, d, 3H; Ar), 7.04 (d, 1H; Ar), 7.34 (t, 1H; Ar), 7.56 (d, AA′XX′, 2H; Ar), 7.76 (d, AA′XX′, 2H; Ar), 10.25 ppm (br, 1H; NH); ^{13}C NMR (62.9 MHz, [D$_6$]DMSO): $\delta = 21.07$ (Ar*C*H$_3$), 21.72 (Ar*C*H$_3$) 82.54 (*C*-CN), 112.11, 114.73, 118.27 (CH), 119.28, 121.29 (C), 121.65, 125.03, 125.50, 129.42, 131.00, 132.18 (CH), 133.02, 139.07, 144.72, 147.64, 149.35, 150.61, 157.14 ppm (C); IR (KBr): $\tilde{\nu} = 3057$ (w, Ar-H), 3032 (w), 2950 (w), 2919 (w, C-H), 2192 (m, C≡N), 1650 (m), 1626 (m), 1589 (s), 1486 (m), 1449 (m), 1346 (m), 1225 (m), 1153 (m), 1115 (m), 1010 (m), 811 (w), 763 (m), 709 cm^{-1} (w); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 458.9 nm (3.98), 281.0 (4.30), 266.6 (4.29); MS (EI, 70 eV): *m*/*z* (%): 428 ([*M*]$^+$, 16), 348 (24), 284 (64).

(*E*)-2-[1-Cyano-1-(3-bromophenyl)methylidene]-7-methyl-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (3e): The reaction (procedure 2) of 3-bromophenylacetonitrile (**1c**; 0.196 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3e** as a red solid (209 mg, 49%, $E/Z >$ 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.21$ (s, 3H; ArC*H*$_3$), 2.24 (s, 3H; ArC*H*$_3$), 6.52–6.65 (m, 2H; Ar), 6.87 (d, $J = 7.6$ Hz, 1H; Ar), 7.06–7.22 (m, 4H; Ar, NH), 7.27–7.44 (m, 2H; Ar), 7.52–7.64 (m, 2H; Ar), 7.86 ppm (s, 1H; Ar); ^{13}C NMR (125.7 MHz, [D$_4$]MeOH): $\delta = 16.28$ (Ar*C*H$_3$), 17.97 (Ar*C*H$_3$), 84.68 (*C*-CN), 117.98 (CH), 119.21, 120.72 (C), 122.44 (CH), 122.85, 124.08 (C), 124.47, 125.65 (CH), 127.53 (C), 127.87, 128.88, 131.86, 132.01, 132.29, 132.86, 136.10 (CH), 137.74, 148.82, 150.42, 150.73, 159.11 ppm (C); IR (KBr): $\tilde{\nu} = 3061$ (w, Ar-H), 3015 (w), 2970 (w), 2922 (w, C–H), 2855 (w), 2197 (m, C≡N), 1645 (m), 1619 (m), 1590 (s), 1492 (m), 1458 (m), 1335 (s), 1219 (s), 1184 (w), 1110 (w), 1077 (w), 1028 (w), 752 (m), 724 cm^{-1} (w); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 461.0 nm (4.01), 286.3 (4.24), 265.4 (4.25); MS (EI, 70 eV): *m*/*z* (%): 428 ([*M*]$^+$, 100), 348 (44), 256 (8); the exact molecular mass for $C_{24}H_{18}N_3Br$ *m*/*z*: 427.0684 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV). The reaction (procedure 3) of **1c** (0.196 g, 1.00 mmol) and **2a** (0.305 g, 1.00 mmol) afforded **3e** as a red solid (360 mg, 84%, $E/Z >$ 98:2).

(*E*)-2-[1-Cyano-1-(2-cyanophenyl)methylidene]-3-phenylimino-2,3-dihydro-1*H*-indole (3f): The reaction (procedure 3) of 2-cyanophenylacetonitrile (**1d**; 0.142 g, 1.00 mmol) and oxalic acid bis(phenylimidoyl) dichloride (**2b**; 0.277 g, 1.00 mmol) afforded **3f** as an orange solid (212 mg, 61%, $E/Z >$ 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 6.90–7.00$ (m, 2H; Ar), 7.05 (d, $J = 7.3$ Hz, 2H; Ar), 7.22–7.29 (m, 1H; Ar), 7.43–7.54 (m, 4H; Ar, NH), 7.61–7.77 (m, 2H; Ar), 8.06 (dd, $J = 7.9$ Hz, $J = 1.8$ Hz, 2H; Ar), 9.08 ppm (d, $J = 8.7$ Hz, 1H; Ar); ^{13}C NMR (75.5 MHz, $CDCl_3$/[D$_4$]methanol = 1:1): $\delta = 85.17$ (C=*C*CN), 114.31 (C), 117.66, 118.63 (CH), 119.63 (C), 124.82, 124.94, 124.96 (CH), 125.26 (C), 125.71, 126.14, 129.33 (CH), 129.50 (C), 129.53, 132.38, 133.45 (CH), 145.36, 149.81, 153.88, 155.19 ppm (C); IR (KBr): $\tilde{\nu} = 3046$ (s, Ar-H), 2808 (m), 2212 (m, C≡N), 1656 (m), 1623 (s), 1596 (m), 1485 (m), 1456 (s), 1403 (s), 1349 (s), 1217 (m), 1165 (m), 1114 (w), 1041 (w), 1028 (w), 797 (m), 756 (m), 717 cm^{-1} (w); UV/Vis (DMF): λ_{max} (lg ε) = 480.1 nm (3.98), 466.3 (3.98), 350.6 (3.63); UV/Vis ($CHCl_3$): λ_{max} = 474.4 nm; MS (EI, 70 eV): *m*/*z* (%): 346 ([*M*]$^+$, 100), 320 (16), 256 (4).

(*E*)-2-[1-Cyano-1-(2-cyanophenyl)methylidene]-7-methyl-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (3g): The reaction (procedure 2) of 2-cyanophenylacetonitrile (**1d**; 0.142 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3g** as a red solid (150 mg, 40%, $E/Z >$ 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.23$ (s, 3H; ArC*H*$_3$), 2.41 (s, 3H; ArC*H*$_3$), 6.80 (d, $J = 7.6$ Hz, 1H; Ar), 6.89–6.96 (m, 2H; Ar), 7.14–7.33 (m, 5H; Ar, NH), 7.59–7.63 (m, 1H; Ar), 7.68 (t, $J = 7.7$ Hz, 1H; Ar), 7.96 (dd, $J = 7.9$ Hz, $J = 1.0$ Hz, 1H; Ar), 8.04 ppm (d, $J = 7.7$ Hz, 1H; Ar); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO, $T = 100\,^\circ$C): $\delta = 16.60$ (Ar*C*H$_3$), 21.28 (Ar*C*H$_3$), 86.95 (*C*-CN), 113.75 (C), 116.17 (CH), 121.45 (C), 121.94, 124.01, 124.47, 124.76 (CH), 125.71 (C), 126.04, 126.21 (CH), 127.03, 127.75 (C), 129.02 (CH), 129.25 (C), 130.29, 131.55, 136.51 (CH), 143.70, 144.60, 148.07, 152.24, 153.43 ppm (C); IR (KBr): $\tilde{\nu} = 3060$ (w, Ar-H), 2975 (w), 2925 (w, C–H), 2853 (w), 2217 (m, C≡N), 1648 (m), 1630 (s), 1611 (m), 1594 (m), 1578 (m), 1477 (s), 1455 (s), 1343 (s), 1280 (m), 1219 (m), 1166 (m), 1157 (m), 1112 (w), 1094 (m), 1017 (w), 794 (w), 767 (m), 749 (s), 736 cm^{-1} (w); UV/Vis (DMF): λ_{max} (lg ε) = 461.4 nm (3.72), 334.8 (3.74); UV/Vis ($CHCl_3$): λ_{max} = 450.1 nm; MS (EI, 70 eV): *m*/*z* (%): 374 ([*M*]$^+$, 100), 348 (8); elemental analysis calcd (%) for $C_{25}H_{18}N_4$ (374.4): C 80.19, H 4.85; found: C 80.21, H 4.61.

(*E*)-2-[1-Cyano-1-(4-methyloxycarbonylphenyl)methylidene]-7-methyl-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (3h): The reaction (procedure 3) of (4-methoxycarbonylphenyl)acetonitrile (**1e**; 0.175 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3h** as a yellow solid (195 mg, 48%, $E/Z >$ 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): $\delta =$ 2.20 (s, 3H; ArC*H*$_3$), 2.24 (s, 3H; ArC*H*$_3$), 3.97 (s, 3H; CO_2CH_3), 6.53–6.66 (m, 2H; Ar), 6.88 (d, $J = 7.7$ Hz, 1H; Ar), 7.09–7.31 (m, 5H; Ar, NH), 7.79 (d, $J = 8.1$ Hz, AA′XX′, 2H; Ar), 8.20 ppm (d, $J = 8.1$ Hz, AA′XX′, 2H; Ar); ^{13}C NMR (75.5 MHz, $CDCl_3$): $\delta = 15.76$ (Ar*C*H$_3$), 18.04 (Ar*C*H$_3$), 52.45 (CO_2CH_3), 85.42 (*C*-CN), 116.93, 118.11 118.65, 119.77, 121.92, 124.07, 124.82, 126.63, 127.01, 128.37, 129.94, 130.06, 130.89, 134.40, 134.47, 145.85, 147.78, 149.05, 156.34, 166.34 ppm; IR (KBr): $\tilde{\nu} = 3060$ (w, Ar-H), 3014 (w), 2950 (w), 2924 (w, C–H), 2196 (m, C≡N), 1710 (s), 1645 (s), 1587 (s), 1493 (m), 1482 (m), 1456 (m), 1342 (s), 1223 (s), 1184 (s), 1112 (s), 770 (m), 748 (s), 721 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 466.9 nm (3.67), 311.8 (3.79), 261.0 (3.97); MS (EI, 70 eV): *m*/*z* (%): 406 ([*M*]$^+$, 100), 392 (84), 348 (66); the exact molecular mass for $C_{26}H_{21}N_3O_2$ *m*/*z*: 407.1633 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

(*E*)-2-[1-Cyano-1-phenyl-methylidene]-6-bromo-3-(3-bromophenyl)imino-2,3-dihydro-1*H*-indole (3i): The reaction (procedure 3) of phenylacetonitrile (**1a**; 0.117 g, 1.00 mmol) and oxalic acid bis(3-bromophenylimidoyl) dichloride (**2d**; 0.435 g, 1.00 mmol) afforded **3i** as an orange solid (213 mg, 44%, $E/Z >$ 98:2). Only the 6-bromo-substituted regioisomer was selectively formed. ^{1}H NMR (250 MHz, [D$_6$]DMSO): $\delta = 6.37$ (d, $J =$ 8.3 Hz, 1H; Ar), 6.86 (d, $J = 8.0$ Hz, 1H; Ar), 7.01 (s, 1H; Ar), 7.19 (d, $J = 9.0$ Hz, 2H; Ar), 7.40–7.46 (m, 3H; Ar), 7.51–7.61 ppm (m, 4H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 86.08$ (*C*-CN), 114.73 (CH), 115.91 (C), 116.75 (CH), 118.66 (C), 120.27 (CH), 122.29 (C), 123.14, 126.68, 126.95 (CH), 127.30 (C), 128.31, 128.56, 129.11, 131.37 (CH), 133.06, 146.04, 150.19, 151.50, 156.76 ppm (C); IR (KBr): $\tilde{\nu} = 2921$ (w), 2192 (w, C≡N), 1645 (s), 1607 (s), 1581 (s), 1465 (m), 1449 (s), 1439 (s), 1337 (s), 1299 (m), 1227 (s), 1214 (m), 1016 (m), 902 (m), 878 (w), 759 (w), 743 (w), 704 cm^{-1} (w); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 461.5 nm (4.01), 289.5 (4.37); MS (EI, 70 eV): *m*/*z* (%): 478 ([*M*]$^+$, 100), 398 (8), 318 (5); elemental analysis calcd (%) for $C_{22}H_{13}N_3Br_2$ (479.2): C 55.15, H 4.21; found: C 55.12, H 2.99. The reaction (procedure 1) of **1a** (0.196 g, 1.00 mmol) and **2d** (0.478 g, 1.10 mmol) afforded **3i** as an orange solid (40 mg, 8%, $E/Z >$ 98:2).

(*E*)-2-[1-Cyano-1-(2-methoxyphenyl)methylidene]-3-phenylimino-2,3-dihydro-1*H*-indole (3j): The reaction (procedure 1) of 2-methoxyphenylacetonitrile (**1f**; 0.147 g, 1.00 mmol) and oxalic acid bis(phenylimidoyl) dichloride (**2b**; 0.277 g, 1.00 mmol) afforded **3j** as a yellow solid (0.192 g, 0.546 mmol, 55%, $E/Z >$ 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 3.86$ (s, 3H; OCH_3), 6.61 (d, $J = 7.4$ Hz, 2H; Ar), 6.77 (d, $J = 8.0$ Hz, 1H; Ar), 7.02–7.13 (m, 5H; Ar, NH), 7.16–7.25 (m, 2H; Ar), 7.41 (ddd, $J = 8.2$ Hz, $J =$ 7.5 Hz, $J = 1.6$ Hz, 3H; Ar), 7.54 ppm (dd, $J = 7.7$ Hz, $J = 1.6$ Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 56.25$ (OCH_3), 83.20 (*C*–CN), 110.53, 112.47 (CH), 114.00 (CN), 118.16 (CH), 118.39, 118.59 (C), 120.85, 121.70 (CH), 121.97 (C), 124.35, 126.81, 129.31, 130.60, 131.27, 133.27 (CH), 147.46,

147.55, 150.67, 156.65 ppm (C); IR (KBr): $\tilde{\nu}$ = 3061 (w), 3014 (w), 2963 (w), 2934 (w), 2192 (m, C≡N), 1646 (s), 1620 (s), 1596 (s), 1485 (s), 1465 (s), 1434 (m), 1345 (s), 1276 (m), 1254 (s), 1217 (s), 1148 (m), 1024 (m), 766 (m), 749 (s), 695 cm^{-1} (m); UV/Vis (CH_3CN): λ_{max} (lg ε) = 464.8 nm (3.93), 275.5 (4.31), 220.9 (4.35); MS (EI, 70 eV): *m*/*z* (%): 353 ([*M*]$^+$, 12), 320 ([*M* − OMe]$^+$, 100), 245 (4).

(*E*)-2-[1-Cyano-1-(2-methoxyphenyl)methylidene]-7-methyl-3-(2-tolyl)-imino-2,3-dihydro-1*H*-indole (3k): The reaction (procedure 1) of 2-methoxyphenylacetonitrile (**1f**; 0.147 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3k** as an orange solid (0.193 g, 0.509 mmol, 51%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): 2.15 (s, 3H; $ArCH_3$), 2.25 (s, 3H; $ArCH_3$), 3.98 (s, 3H; OCH_3), 6.48 (d, *J* = 7.2 Hz, 1H; Ar), 6.56 (dd, *J* = 7.7 Hz, *J* = 7.3 Hz, 1H; Ar), 6.90 (d, *J* = 7.7 Hz, 1H; Ar), 7.01 (br, 1H; Ar), 7.05–7.13 (m, 4H; Ar), 7.15- 7.29 (m, 3H; Ar), 7.43 (ddd, *J* = 8.4 Hz, *J* = 7.3 Hz, *J* = 1.7 Hz, 1H; Ar), 7.64 ppm (dd, *J* = 7.7 Hz, *J* = 1.7 Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 15.70 ($ArCH_3$), 18.03 ($ArCH_3$), 56.17 (OCH_3), 83.22 (*C*−CN), 112.53, 117.06 (CH), 118.29, 119.29, 119.40 (C), 121.06, 121.92 (CH), 122.30 (C), 123.94, 124.36, 126.47 (CH), 126.96 (C), 130.47, 130.68, 131.43, 134.02 (CH), 146.26, 147.44, 149.30, 156.21, 156.46 ppm (C); IR (KBr): $\tilde{\nu}$ = 3063 (w), 3014 (w), 2962 (w), 2936 (w), 2195 (m, C≡N), 1646 (m), 1619 (m), 1595 (s), 1492 (s), 1460 (s), 1434 (m), 1338 (s), 1268 (m), 1249 (m), 1223 (s), 1182 (m), 1112 (m), 1072 (m), 1023 (m), 851 (w), 795 (w), 750 cm^{-1} (s); UV/Vis (CH_3CN): λ_{max} (lg ε) = 462.2 nm (3.85), 275.9 (4.30); MS (ESI): *m*/*z* (%): 781 ([2*M*+Na]$^+$, 50), 402 ([*M*+Na]$^+$, 100), 348 (40).

(*E*)-2-[1-Cyano-1-(2-methoxyphenyl)methylidene]-6-methyl-3-(3-tolyl)-imino-2,3-dihydro-1*H*-indole (3l): The reaction (procedure 1) of 2-methoxyphenylacetonitrile (**1f**; 0.147 g, 1.00 mmol) and oxalic acid bis(3-tolylimidoyl) dichloride (**2c**; 0.305 g, 1.00 mmol) afforded **3l** as an orange solid (0.268 g, 0.707 mmol, 71%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.25 (s, 3H; $ArCH_3$), 2.36 (s, 3H; $ArCH_3$), 3.93 (s, 3H; OCH_3), 6.43 (d, *J* = 8.2 Hz, 1H; Ar), 6.56 (d, *J* = 7.8 Hz, 1H; Ar), 6.57 (s, 1H; Ar), 6.83 (d, *J* = 7.5 Hz, 1H; Ar), 6.87 (s, 1H; Ar), 6.94–7.12 (m, 4H; Ar, NH), 7.27 (t, *J* = 7.7 Hz, 1H; Ar), 7.41 (td, *J* = 7.5 Hz, *J* = 1.1 Hz, 1H; Ar), 7.53 ppm (dd, *J* = 7.5 Hz, *J* = 1.7 Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 22.11 ($ArCH_3$), 25.20 ($ArCH_3$), 56.26 (OCH_3), 82.64 (*C*−CN), 110.95, 112.48, 115.16 (CH), 116.14 (C), 118.98, 121.70, 121.94 (CH), 122.14, 123.80 (C), 124.92, 126.59, 129.04, 130.49, 131.30 (CH), 139.13, 144.43, 144.47, 147.88, 148.01, 150.79, 156.64 ppm (C); IR (KBr): $\tilde{\nu}$ = 3059 (w), 3017 (w), 2992 (w), 2921 (w), 2191 (m, C≡N), 1646 (m), 1627 (s), 1594 (s), 1583 (s), 1490 (s), 1456 (s), 1436 (m), 1345 (s), 1273 (m), 1250 (s), 1220 (m), 1154 (m), 1116 (m), 1026 (m), 809 (w), 756 (m), 749 cm^{-1} (m); UV/Vis (CH_3CN): λ_{max} (lg ε) = 461.7 nm (3.87), 280.7 (4.38); MS (EI, 70 eV): *m*/*z* (%): 379 ([*M*]$^+$, 8), 348 ([*M* − OMe]$^+$, 100), 332 (4).

(*E*)-2-[1-Cyano-1-(2-methoxyphenyl)methylidene]-5,7-dimethyl-3-(2,4-dimethylphenyl)imino-2,3-dihydro-1*H*-indole (3m): The reaction (procedure 1) of 2-methoxyphenylacetonitrile (**1f**; 0.441 g, 3.00 mmol) and oxalic acid bis(2,4-dimethylphenylimidoyl) dichloride (**2e**; 1.005 g, 3.00 mmol) afforded **3m** as an orange solid (0.758 g, 1.860 mmol, 62%, *E*/*Z* > 98:2). ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.04, 2.11, 2.25, 2.37 (4 s, 4 × 3H; $ArCH_3$), 3.94 (s, 3H; OCH_3), 6.44 (s, 1H; Ar), 6.80 (d, *J* = 7.9 Hz, 1H; Ar), 6.89 (s, 1H; Ar), 6.98 (s, 1H; Ar), 7.02–7.13 (m, 4H; Ar, NH), 7.39 (t, *J* = 7.4 Hz, 1H; Ar), 7.61 ppm (dd, *J* = 7.7 Hz, *J* = 1.5 Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 15.55 ($ArCH_3$), 17.94 ($ArCH_3$), 20.72 ($ArCH_3$), 20.87 ($ArCH_3$), 55.94 (OCH_3), 82.18 (*C*-CN), 109.99 (C), 112.36, 116.89 (CH), 118.27, 119.06, 119.50 (C), 121.67 (CH), 122.31 (C), 123.83, 126.69 (CH), 127.15, 130.17 (C), 130.21, 131.22, 131.26 (CH), 133.75 (C), 134.81 (CH), 144.26, 146.53, 148.01, 156.12 ppm (C); IR (KBr): $\tilde{\nu}$ = 3064 (w), 3001 (w), 2967 (w), 2943 (m), 2918 (m), 2196 (m, C≡N), 1644 (m), 1618 (s), 1594 (s), 1481 (s), 1435 (m), 1383 (m), 1332 (s), 1282 (m), 1249 (m), 1234 (m), 1204 (s), 1179 (m), 1119 (m), 1022 (m), 827 (w), 770 (m), 753 cm^{-1} (m); UV/Vis (CH_3CN): λ_{max} (lg ε) = 474.5 nm (3.97), 280.3 (4.39); MS (EI, 70 eV): *m*/*z* (%): 407 ([*M*]$^+$, 3), 406 ([*M* − H]$^+$, 6), 392 (8), 376 (100), 360 (2).

(*E*)-2-[1-Cyano-1-(3-methoxyphenyl)-methylidene]-5-methyl-3-(4-tolyl)-imino-2,3-dihydro-1*H*-indole (3n): The reaction (procedure 3) of 3-methoxyphenylacetonitrile (**1g**; 0.147 g, 1.00 mmol) and oxalic acid bis(4-tolylimidoyl) dichloride (**2f**; 0.336 g, 1.10 mmol) afforded **3n** as a red solid (0.226 g, 0.596 mmol, 60%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.06 (s, 3H; $ArCH_3$), 2.40 (s, 3H; $ArCH_3$), 3.85 (s, 3H; OCH_3), 6.61 (s, 1H; Ar), 6.70 (d, *J* = 8.1 Hz, 1H; Ar), 6.93 (d, *J* = 8.2 Hz, 1H; Ar), 7.03 (d, *J* = 8.1 Hz, 1H; Ar), 7.15–7.26 (m, 5H; Ar, NH), 7.33(s, 1H; Ar), 7.39 ppm (t, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 20.89 ($ArCH_3$), 21.05 ($ArCH_3$), 55.43 (OCH_3), 85.14 (*C*−CN), 110.38, 114.02, 114.07, 118.32 (CH), 119.19 (C), 120.75, 126.82, 129.76 (CH), 130.47, 130.49 (C), 130.52, 134.03 (CH), 134.15, 135.25, 145.38, 147.65, 147.72, 156.28, 160.31 ppm (C); IR (KBr): $\tilde{\nu}$ = 3024 (w), 2996 (w), 2920 (m), 2860 (w), 2193 (m, C≡N), 1643 (s), 1620 (s), 1586 (s), 1502 (s), 1488 (s), 1434 (m), 1333 (s), 1290 (m), 1262 (m), 1225 (s), 1201 (s), 1170 (m), 1120 (m), 1048 (m), 830 (m), 817 (m), 784 (w), 767 (w), 697 cm^{-1} (w); UV/Vis (CH_3CN): λ_{max} (lg ε) = 480.6 nm (4.00), 282.8 (4.29), 222.6 (4.44); MS (EI, 70 eV): *m*/*z* (%): 379 ([*M*]$^+$, 60), 378 ([*M* − 1]$^+$, 100), 352 (44), 335 (10).

(*E*)-2-[1-Cyano-1-(4-methoxyphenyl)methylidene]-7-methyl-3-(2-tolyl)-imino-2,3-dihydro-1*H*-indole (3o): The reaction (procedure 1) of 4-methoxyphenylacetonitrile (**1h**; 0.147 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3o** as a red solid (0.115 g, 0.303 mmol, 30%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.19 (s, 3H; $ArCH_3$), 2.24 (s, 3H; $ArCH_3$), 3.86 (s, 3H; OCH_3), 6.48–6.61 (2 t, *J* = 7.5 Hz, 2H; Ar), 6.87 (d, *J* = 7.6 Hz, 1H; Ar), 7.02–7.13 (m, 5H; Ar, NH), 7.19 (d, *J* = 7.5 Hz, 1H; Ar), 7.27 (d, *J* = 7.6 Hz, 1H; Ar), 7.61 ppm (d, *J* = 8.8 Hz, 2H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 15.71 ($ArCH_3$), 17.93 ($ArCH_3$), 55.37 (OCH_3), 86.40 (*C*-CN), 114.99, 116.98 (CH), 118.21, 119.21, 119.59 (C), 121.20, 123.83, 124.33 (CH), 125.81 (C), 126.47 (CH), 126.81 (C), 129.72, 130.66, 134.09 (CH), 146.11, 146.38, 149.26, 156.31, 159.57 ppm (C); IR (KBr): $\tilde{\nu}$ = 3063 (w), 3010 (w), 2956 (w), 2930 (w), 2198 (m, C≡N), 1644 (m), 1599 (s), 1510 (s), 1489 (m), 1459 (m), 1430 (m), 1381 (w), 1336 (s), 1301 (m), 1253 (s), 1219 (s), 1181 (s), 1111 (w), 1034 (m), 835 (m), 797 (w), 776 (w), 746 cm^{-1} (m); UV/Vis (CH_3CN): λ_{max} (lg ε) = 470.2 nm (4.02), 275.6 (4.32), 229.3 (4.29); MS (EI, 70 eV): *m*/*z* (%): 379 ([*M*]$^+$, 50), 378 ([*M* − 1]$^+$, 100), 364 (24), 348 (12), 335 (4); the exact molecular mass for $C_{25}H_{21}N_3O$ *m*/*z*: 379.1685 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

(*E*)-2-[1-Cyano-1-(2-tolyl)-methylidene]-3-phenylimino-2,3-dihydro-1*H*-indole (3p): The reaction (procedure 1) of 2-tolylacetonitrile (**1i**; 0.131 g, 1.00 mmol) and oxalic acid bis(phenylimidoyl) dichloride (**2b**; 0.277 g, 1.00 mmol) afforded **3p** as a yellow solid (0.249 g, 0.744 mmol, 74%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.45 (s, 3H; $ArCH_3$), 6.58–6.74 (m, 4H; Ar, NH), 7.05 (dd, *J* = 8.3 Hz, *J* = 1.1 Hz, 2H; Ar), 7.16–7.46 ppm (m, 8H; Ar); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 19.82 ($ArCH_3$), 85.07 (*C*-CN), 110.49, 118.17 (CH), 118.34 (C), 120.97, 124.50, 126.85, 126.90, 129.35, 129.36, 130.05, 131.36 (CH), 131.77 (C), 133.42 (CH), 137.94, 137.95, 147.32, 147.85, 150.85, 156.02 ppm (C); IR (KBr): $\tilde{\nu}$ = 3059 (w, Ar-H), 3025 (w), 2953 (w), 2922 (w, C−H), 2187 (m, C≡N), 1647 (m), 1620 (m), 1588 (s), 1483 (m), 1465 (s), 1344 (s), 1220 (s), 1149 (m), 1101 (w), 1024 (w), 767 (w), 747 (m), 716 cm^{-1} (w); UV/Vis (CH_3CN): λ_{max} (lg ε) = 458.7 nm (3.95), 274.6 (4.36), 226.0 (4.31); MS (EI, 70 eV): *m*/*z* (%): 334 ([*M*]$^+$, 16), 320 (100), 243 (4); elemental analysis calcd (%) for $C_{23}H_{17}N_3$ (335.4): C 82.36, H 5.11, N 12.53; found: C 82.21, H 5.41, N 12.41.

(*E*)-2-[1-Cyano-1-(3-tolyl)methylidene]-5-methyl-3-(4-tolyl)imino-2,3-dihydro-1*H*-indole (3q): The reaction (procedure 1) of 3-tolylacetonitrile (**1j**; 0.131 g, 1.00 mmol) and oxalic acid bis(4-tolylimidoyl)chloride (**2f**; 0.305 g, 1.00 mmol) afforded **3q** as a red solid (0.225 g, 0.618 mmol, 62%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.04 (s, 3H; $ArCH_3$), 2.40 (s, 6H; 2 $ArCH_3$), 6.60 (s, 1H; Ar), 6.72 (d, *J* = 8.0 Hz, 1H; Ar), 6.92 (d, *J* = 8.1 Hz, 2H; Ar), 7.01 (d, *J* = 8.2 Hz, 1H; Ar), 7.15–7.26 (m, 3H; Ar), 7.32–7.43 ppm (m, 4H; Ar, NH); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 20.86 ($ArCH_3$), 21.03 ($ArCH_3$), 21.47 ($ArCH_3$), 85.36 (*C*-CN), 110.44 (CH), 118.27 (C), 118.32 (CH), 119.42 (C), 125.47, 126.75, 129.14, 129.17, 129.25, 129.73 (CH), 130.29, 133.80 (C), 133.99 (CH), 134.05, 139.35, 145.52, 147.50, 147.78, 156.37 ppm (C); IR (KBr): $\tilde{\nu}$ = 3023 (w), 2946 (w), 2946 (w), 2919 (m), 2195 (m, C≡N), 1662 (m), 1642 (s), 1621 (s), 1586 (s), 1502 (s), 1487 (s), 1438 (m), 1382 (m), 1330 (s), 1289 (m), 1250 (m), 1223 (s), 1205 (m), 1119 (m), 1036 (w), 830 (w), 790 (w), 701 cm^{-1} (w); UV/Vis (CH_3CN): λ_{max} (lg ε) = 480.7 nm (4.00), 308.1 (4.14), 284.0 (4.28); MS (EI, 70 eV): *m*/*z* (%): 363 ([*M*]$^+$, 56), 362 ([*M* − H]$^+$, 100), 348 (52); the exact molecular mass for $C_{25}H_{21}N_3$ *m*/*z*: 363.1735 ± 2 mD ([*M*]$^+$) (363.1691 for the *M* − H isotope fragment $^{12}C_{24}{}^{13}C_1H_{20}N_3$) was confirmed by HRMS (EI, 70 eV).

(*E*)-2-[1-Cyano-1-(4-tolyl)methylidene]-4,6-dimethyl-3-(3,5-dimethylphenyl)imino-2,3-dihydro-1*H*-indole (3r): The reaction (procedure 3) of 4-tolylacetonitrile (**1k**; 0.131 g, 1.00 mmol) and oxalic acid bis(3,5-dimethylphenylimidoyl) dichloride (**2g**; 0.367 g 1.10 mmol) afforded **3r** as a red solid (0.378 g, 0.964 mmol, 96%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): δ = 2.04, 2.14, 2.24, 2.37, 2.41 (5s, 5 × 3H; $ArCH_3$), 6.46 (s, 1H; Ar), 6.77 (d,

$J = 7.9$ Hz, 1H; Ar), 6.90 (s, 1H; Ar), 6.99–7.10 (m, 3H; Ar, NH), 7.31 (d, $J = 8.1$ Hz, AA′, 2H; Ar), 7.57 ppm (d, $J = 8.2$ Hz, XX′, 2H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 15.65$, 18.00, 20.82, 20.96, 21.29 (Ar*C*H$_3$), 85.73 (*C*-CN), 116.93 (CH), 118.35, 119.10, 119.39 (C), 123.99, 126.81 (CH), 127.28 (C), 128.22, 130.23 (CH), 130.55, 131.11 (C), 131.36 (CH), 133.99 (C), 134.96 (CH), 138.45, 144.11, 146.52, 147.36, 156.15 ppm (C); IR (KBr): $\tilde{\nu} =$ 3024 (w), 3010 (w), 2971 (w), 2944 (m), 2919 (m), 2861 (w), 2195 (m, C≡N), 1675 (m), 1646 (s), 1615 (s), 1583 (s), 1521 (m), 1510 (s), 1481 (s), 1448 (m), 1376 (m), 1329 (s), 1312 (m), 1225 (m), 1203 (s), 1120 (w), 1019 (w), 818 (m), 795 (w), 771 cm^{-1} (w); UV/Vis (CH_3CN): λ_{max} (lg ε) = 481.3 nm (3.92), 284.5 (4.28), 235.1 (4.24); MS (EI, 70 eV): *m*/*z* (%): 391 ([*M*]$^+$, 56), 390 ([*M* − H]$^+$, 100), 376 (58).

(*E*)-2-{1-Cyano-1-[2-(*N*-methyl)pyrrolyl]methylidene}-7-methyl-3-(2-tolyl)-imino-2,3-dihydro-1*H*-indole (3w): The reaction (procedure 2) of 2-(*N*-methyl)pyrrolylacetonitrile (**1m**; 0.121 g, 1.00 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.305 g, 1.00 mmol) afforded **3w** as an orange solid (0.042 g, 0.119 mmol, 12%, *E*/*Z* > 98:2); ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.19$ (s, 3H; Ar*CH*$_3$), 2.25 (s, 3H; Ar*CH*$_3$), 3.83 (s, 3H; NCH$_3$), 6.27–6.30 (m, 1H; Ar), 6.40–6.42 (m, 1H; Ar), 6.50–6.61 (m, 2H; Ar), 6.89 (d, $J = 7.8$ Hz, 1H; Ar), 7.06–7.36 ppm (m, 6H; Ar, NH); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 15.71$ (Ar*C*H$_3$), 17.86 (Ar*C*H$_3$), 35.19 (NCH$_3$), 77.34 (*C*-CN), 108.76, 110.44, 117.02 (CH), 117.68, 118.30, 119.43 (C), 121.19, 123.94 (CH), 124.07 (C), 124.49, 124.90, 126.47 (CH), 127.02 (C), 130.71, 134.15 (CH), 145.73, 148.06, 149.19, 156.02 ppm (C); IR (KBr): $\tilde{\nu} = 3061$ (w, Ar-H), 3012 (w), 2952(s), 2923 (s, C–H), 2853 (s), 2195 (m, C≡N), 1644 (m), 1618 (m), 1587 (s), 1492 (m), 1458 (m), 1339 (s), 1218 (s), 1181 (m), 1109 (w), 1040 (w), 794 (w), 746 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 483.4 nm (3.78), 276.4 (4.13), 254.4 (4.00); MS (EI, 70 eV): *m*/*z* (%): 352 ([*M*]$^+$, 100), 296 (4); the exact molecular mass for $C_{23}H_{20}N_4$ *m*/*z*: 352.1688 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

12-Cyano-11-phenylimino-5,11-dihydroindolo[1,2-*b*]isoquinolin-5-one (5a): The reaction (procedure 3) of methyl 2-(cyanomethyl)benzoate (**4**; 0.088 g, 0.50 mmol) and oxalic acid bis(phenylimidoyl) dichloride (**2b**; 0.153 g, 0.55 mmol) afforded **5a** as a yellow solid (144 mg, 83%). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 6.94$ (d, $J = 7.8$ Hz, 1H; Ar), 7.06 (m, 3H; Ar), 7.28 (m, 1H; Ar), 7.47 (dd, $J = 8.0$ Hz, $J = 7.3$ Hz, 2H; Ar), 7.56 (dd, $J = 7.1$ Hz, $J = 1.4$ Hz, 1H; Ar), 7.72 (td, $J = 8.0$ Hz, $J = 1.1$ Hz, 1H; Ar), 7.88 (td, $J = 8.2$ Hz, $J = 1.4$ Hz, 1H; Ar), 8.16 (d, $J = 8.7$ Hz, 1H; Ar), 8.56 (dd, $J = 8.0$ Hz, $J = 0.9$ Hz, 1H; Ar), 8.79 ppm (d, $J = 8.2$ Hz, 1H; Ar); ^{13}C NMR (75.5 MHz, $CDCl_3$, $T = 50\,^\circ$C): $\delta = 84.80$ (*C*-CN), 118.10, 118.31 (CH), 120.28 (C), 125.39, 126.17, 126.20, 126.24 (CH), 127.30 (C), 128.73, 129.59 (CH), 129.68 (C), 129.83 (CH), 133.18 (C), 133.95, 134.14 (CH), 140.85, 144.69, 150.01, 153.75 (C), 158.86 ppm (C=O); IR (KBr): $\tilde{\nu} = 3071$ (m, Ar-H), 2219 (m, C≡N), 1669 (s), 1659 (s), 1603 (m), 1596 (s), 1487 (m), 1457 (s), 1401 (m), 1366 (s), 1336 (m), 1233 (m), 1127 (m), 779 (s), 757 (s), 719 (m), 704 cm^{-1} (s); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 422.6 nm (4.04), 403.2 (4.00), 322.8 (3.93); MS (EI, 70 eV): *m*/*z* (%): 347 ([*M*]$^+$, 100), 318 (4).

12-Cyano-7-methyl-11-(2-tolylimino)-5,11-dihydroindolo[1,2-*b*]isoquinolin-5-one (5b): The reaction (procedure 3) of methyl 2-(cyanomethyl)benzoate (**4**; 0.088 g, 0.50 mmol) and oxalic acid bis(2-tolylimidoyl) dichloride (**2a**; 0.168 g, 0.55 mmol) afforded **5b** as an orange solid (93 mg, 50%). ^{1}H NMR (500 MHz, $CDCl_3$): $\delta = 2.21$ (s, 3H; CH$_3$, C-2′), 2.60 (s, 3H; CH$_3$, C-7), 6.81 (d, $J = 7.8$ Hz, 1H; Ar, C-10), 6.88 (dd, $J = 7.8$ Hz, $J = 1.1$ Hz, 1H; Ar, C-6′), 6.96 (dd, $J = 7.8$ Hz, $J = 7.6$ Hz, 1H; Ar, C-9), 7.15 (td, $J = 7.5$ Hz, $J = 1.3$ Hz, 1H; Ar, C-4′), 7.23 (td, $J = 7.7$ Hz, $J = 0.8$ Hz, 1H; Ar, C-5′), 7.31 (d, $J = 7.5$ Hz, 1H; Ar, C-3′), 7.34 (d, $J = 7.5$ Hz, 1H; Ar, C-8), 7.67 (td, $J = 7.9$ Hz, $J = 1.1$ Hz, 1H; Ar, C-3), 7.85 (td, $J = 8.0$ Hz, $J = 1.4$ Hz, 1H; Ar, C-2), 8.10 (dd, $J = 8.0$ Hz, $J = 1.1$ Hz, 1H; Ar, C-1), 8.46 ppm (dd, $J = 8.0$ Hz, $J = 1.4$ Hz, 1H; Ar, C-4); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 17.96$ (C2′-*C*H$_3$), 23.34 (C7-*C*H$_3$), 89.80 (*C*-*12*-CN), 114.10 (C=N), 116.67 (C-10), 122.45 (C-10a), 123.25 (C-10), 125.27 (C-4′), 125.61 (C-1), 126.69 (C-9&C-5′), 126.98 (C-2′), 127.87 (C-4a), 128.68 (C-4), 129.00 (C-7), 129.59 (C-3), 131.02 (C-3′), 133.06 (C-12a), 133.88 (C-2), 137.78 (C-8), 143.28 (C-6a), 143.49 (C-11), 148.49 (C-1′), 153.36 (C-11a), 158.40 ppm (C=O); IR (KBr): $\tilde{\nu} = 3062$ (w), 2959 (w), 2921 (m), 2850 (w), 2217 (m, C≡N), 1684 (s), 1653 (s), 1635 (s), 1616 (s), 1602 (m), 1576 (m), 1559 (m), 1539 (m), 1481 (s), 1457 (m), 1436 (m), 1354 (m), 1310 (s), 1275 (m), 1241 (m), 1107 (m), 798 (m), 764 (m), 748 cm^{-1} (s); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 426.0 nm (4.02), 408.5 (4.05), 326.6 (3.99); MS (ESI): *m*/*z* (%): 1147 ([3*M*+Na]$^+$, 70), 773 ([2*M*+Na]$^+$, 100), 398 ([*M*+Na]$^+$, 50), 376 ([*M*+H]$^+$, 6); elemental analysis calcd (%) for $C_{25}H_{17}N_3O$ (375.4): C 79.98, H 4.56; found: C 79.78, H 4.79.

12-Cyano-8-methyl-11-(3-tolylimino)-5,11-dihydroindolo[1,2-*b*]isoquinolin-5-one (5c) and 12-cyano-10-methyl-11-(3-tolylimino)-5,11-dihydroindolo[1,2-*b*]isoquinolin-5-one (5d): The reaction (procedure 3) of methyl 2-(cyanomethyl)benzoate (**4**; 0.088 g, 0.50 mmol) and oxalic acid bis(3-tolylimidoyl)chloride (**2c**; 0.168 g, 0.55 mmol) afforded the regioisomers **5c/5d** as a yellow solid (104 mg, 55%). The product was obtained as an inseparable 2.4:1 mixture of **5c** (73 mg, 39%) and **5d** (31 mg, 16%). The regioisomeric ratio was determined by integration of the ^{1}H NMR spectrum (characteristic singlet of the proton at C-7). Spectroscopic data: **5c**: ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.40$ (s, 6H; Me), 6.83 (s, 1H; Ar, C-2′), 6.87 (d, $J = 7.9$ Hz, 2H; Ar), 6.98 (d, $J = 7.5$ Hz, 1H; Ar), 7.06 (d, $J = 7.5$ Hz, 1H; Ar), 7.33 (t, $J = 7.7$ Hz, 1H; Ar), 7.67 (t, $J = 7.3$ Hz, 1H; Ar), 7.84 (t, $J = 7.2$ Hz, 1H; Ar), 8.09 (d, $J = 8.0$ Hz, 1H; Ar), 8.48 (d, $J = 7.9$ Hz, 1H; Ar), 8.56 ppm (s, 1H; Ar, C7); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 21.47$ (CH_3), 22.36 (CH_3), 89.55 (*C*-CN), 113.75 (CN), 114.93 (CH), 117.77 (C), 118.57, 118.79, 125.87, 125.89, 125.90 (CH), 126.93 (C), 127.05, 128.52, 129.27, 129.65 (CH), 132.93 (C), 134.03 (CH), 137.74, 139.46, 144.65, 145.38, 149.96, 153.29 (C), 158.74 ppm (C=O). **5d**: ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.37$ (s, 6H; Me), 6.73 (d, 1H; Ar), 6.78 (d, 1H; Ar), 6.82 (s, 1H; Ar, C-2′), 6.87 (d, $J = 7.9$ Hz, 2H; Ar), 7.43 (t, $J = 7.9$ Hz, 1H; Ar), 7.67 (t, $J = 7.3$ Hz, 1H; Ar), 7.84 (t, $J = 7.2$ Hz, 1H; Ar), 8.07 (t, $J = 8.0$ Hz, 1H; Ar), 8.48 (d, $J = 7.9$ Hz, 1H; Ar), 8.68 ppm (d, $J = 8.2$ Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 21.41$ (CH_3), 22.36 (CH_3), 89.55 (*C*-CN), 113.75 (CN), 115.35, 116.30 (CH), 117.77 (C), 120.23, 125.76, 125.81 (CH), 126.71 (C), 128.49, 128.77, 129.39, 129.98 (CH), 133.02 (C), 133.50, 133.95 (CH), 137.74, 138.90, 142.51, 144.65, 150.26, 152.10 (C), 158.74 ppm (C=O). **5c/5d**: IR (KBr): $\tilde{\nu} = 3062$ (m, Ar-H), 2922 (w), 2221 (m, C≡N), 1682 (s), 1654 (s), 1598 (s), 1479 (m), 1450 (m), 1367 (s), 1308 (s), 1254 (m), 1141 (m), 788 (m), 772 (m), 760 (m), 705 (m), 690 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 419.9 nm (4.02), 403.4 (3.99), 323.9 (4.03); MS (ESI): *m*/*z* (%): 1523 ([4*M*+Na]$^+$, 5), 1148 ([3*M*+Na]$^+$, 55), 773 ([2*M*+Na]$^+$, 98), 398 ([*M*+Na]$^+$, 100).

12-Cyano-9-methyl-11-(4-tolylimino)-5,11-dihydroindolo-[1,2-*b*]isoquinolin-5-one (5e): The reaction (procedure 3) of methyl 2-(cyanomethyl)benzoate (**4**; 0.104 g, 0.59 mmol) and oxalic acid bis(4-tolylimidoyl) dichloride (**2f**; 0.217 g, 0.71 mmol) afforded **5e** as a red solid (190 mg, 85%). ^{1}H NMR (300 MHz, $CDCl_3$): $\delta = 2.17$ (s, 3H; Me), 2.44 (s, 3H; Me), 6.90 (dd, $^4J = 1.5$ Hz, $^5J = 0.6$ Hz, 1H; Ar, C-10), 6.98 (d, $^3J = 8.2$ Hz, AA′XX′, 2H; Ar, C-3′, C-5′), 7.25 (d, $^3J = 8.0$ Hz, AA′XX′, 2H; Ar, C-2′, C-6′), 7.30 (dd, $^3J = 8.0$ Hz, $^4J = 1.3$ Hz, 1H; Ar, C-8), 7.65 (ddd, $^3J = 8.2$ Hz, $^3J = 7.2$ Hz, $^4J = 1.1$ Hz, 1H; Ar, C-3), 7.83 (ddd, $^3J = 7.3$ Hz, $^3J = 7.2$ Hz, $^4J = 1.5$ Hz, 1H; Ar, C-2), 8.12 (ddd, $^3J = 7.6$ Hz, $^4J = 1.0$ Hz, $^5J = 0.6$ Hz, 1H; Ar, C-1), 8.51 (ddd, $^3J = 7.9$ Hz, $^4J = 1.4$ Hz, $^5J = 0.6$ Hz, 1H; Ar, C-4), 8.63 ppm (d, $^3J = 8.4$ Hz, 1H; Ar, C-7); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 21.08$ (C9-*C*H$_3$), 21.22 (C4′-*C*H$_3$), 89.10 (C12-CN), 113.86 (CN), 117.86 (C-7), 118.44 (C-2′ and C-6′), 120.40 (C-10a), 126.02 (C-1), 126.27 (C-10), 127.13 (C-4a), 128.57 (C-4), 129.60 (C-3), 129.97 (C-3′ and C-5′), 133.20 (C-12a), 133.96 (C-2), 134.47 (C-8), 134.50 (C-11), 135.30 (C-4′), 136.18 (C-9), 142.53 (C-6a), 147.24 (C-1′), 153.10 (C-11a), 158.68 ppm (C=O); IR (KBr): $\tilde{\nu} = 3065$ (w, Ar-H), 3029 (w), 2977 (w), 2923 (m), 2225 (m, C≡N), 1677 (s), 1650 (s), 1618 (m), 1600 (m), 1502 (m), 1478 (s), 1458 (m), 1356 (m), 1334 (s), 1301 (m), 1236 (m), 1213 (m), 1171 (m), 842 (m), 822 (m), 773 (m), 763 (m), 689 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 430.5 nm (4.01), 336.9 (4.02), 324.8 (4.02); MS (EI, 70 eV): *m*/*z* (%): 375 ([*M*]$^+$, 100), 362 (15), 268 (60).

12-Cyano-8,10-dimethyl-11-(3,5-dimethylphenylimino)-5,11-dihydroindolo-[1,2-*b*]isoquinolin-5-one (5f): The reaction (procedure 3) of methyl 2-(cyanomethyl)benzoate (**4**; 0.189 g, 1.08 mmol) and oxalic acid bis(3,5-dimethylphenylimidoyl)chloride (**2g**; 0.431 g, 1.29 mmol) afforded **5f** as a red solid (418 mg, 96%). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.14$ (s, 3H; Me), 2.23 (s, 3H; Me), 2.39 (s, 3H; Me), 2.59 (s, 3H; Me), 6.79, 6.83 (2s, 2 × 1H; Ar, C-2′ + C-6′), 7.03 (s, 1H; Ar, C-7), 7.15 (s, 1H; Ar, C-9), 7.17 (s, 1H; Ar, C-4′), 7.66 (t, $^3J = 7.9$ Hz, 1H; Ar, C-3), 7.84 (td, $^3J = 8.1$ Hz, $^4J = 1.1$ Hz, 1H; Ar, C-2), 8.10 (d, $^3J = 8.1$ Hz, 1H; Ar, C-1), 8.46 ppm (d, $^3J = 8.4$ Hz, 1H; Ar, C-4); ^{13}C NMR (75.5 MHz, $CDCl_3$): $\delta = 18.02$ (CH_3), 20.89 (CH_3), 21.04 (CH_3), 23.28 (CH_3), 89.37 (C12-CN), 114.34 (CN), 116.75 (C-2′), 122.73 (C), 123.50 (C-6′), 125.58 (C-1), 126.98 (C-7), 127.70 (C), 127.87 (C-4a), 128.55 (C),128.65 (C-4), 129.40 (C-3), 131.69 (C-9), 133.24 (C-12a), 133.76 (C-2), 135.16, 136.53 (C), 138.40 (C-4′), 141.44 (C), 144.05 (C-10a), 145.80, 153.03 (C), 158.42 ppm (C=O); IR (KBr): $\tilde{\nu} = 3065$ (m, Ar-H), 3013 (w), 2971 (w),

2922 (m), 2218 (m, C≡N), 1688 (s), 1651 (s), 1606 (s), 1490 (s), 1477 (s), 1457 (m), 1378 (m), 1353 (m), 1330 (s), 1310 (s), 1279 (s), 1177 (s), 772 (m), 762 (m), 687 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 418.0 nm (3.80), 325.6 (3.98); MS (EI, 70 eV): *m/z* (%): 403 ($[M]^+$, 100), 388 (40), 376 (4); the exact molecular mass for $C_{27}H_{21}N_3O$ *m/z*: 403.1685 ± 2 mD ($[M]^+$) was confirmed by HRMS (EI, 70 eV).

12-Cyano-9-methoxy-11-(4-methoxyphenylimino)-5,11-dihydroindolo-[1,2-*b*]isoquinolin-5-one (5g): The reaction (procedure 3) of methyl 2-(cyanomethyl)benzoate (**4**; 0.088 g, 0.50 mmol) and oxalic acid bis(4-methoxyxphenylimidoyl) dichloride (**2h**; 0.202 g, 0.60 mmol) afforded **5g** as a red solid (178 mg, 87%). ^{1}H NMR (250 MHz, $CDCl_3$): δ = 3.60 (s, 3H; OCH_3), 3.87 (s, 3H; OCH_3), 6.76 (d, *J* = 2.7 Hz, 1H; Ar), 7.00–7.08 (m, 3H; Ar), 7.10–7.15 (m, 2H; Ar), 7.68 (td, *J* = 8.2 Hz, *J* = 1.1 Hz, 1H; Ar), 7.85 (td, *J* = 7.9 Hz, *J* = 1.4 Hz, 1H; Ar), 8.11 (d, *J* = 7.9 Hz, 1H; Ar), 8.52 (dd, *J* = 8.0 Hz, *J* = 1.2 Hz, 1H; Ar), 8.67 ppm (d, *J* = 8.9 Hz, 1H; Ar); ^{13}C NMR (75.5 MHz, $CDCl_3$, *T* = 50 °C): δ = 55.57 (OCH_3), 55.71 (OCH_3), 89.45 (*C*-CN), 110.48 (CH), 113.93 (C), 114.84, 119.09, 119.55, 120.58 (CH), 121.39 (C), 126.04 (CH), 127.20 (C), 128.54, 129.56 (CH), 133.27 (C), 133.86 (CH), 138.50, 142.75, 142.78, 153.09, 157.68, 158.28, 158.50 ppm (C); IR (KBr): $\tilde{\nu}$ = 2960 (w), 2220 (m, C≡N), 1674 (s), 1649 (s), 1604 (s), 1586 (s), 1502 (s), 1477 (s), 1433 (s), 1302 (s), 1260 (m), 1247 (s), 1210 (m), 1168 (m), 1026 (m), 848 (m), 770 (m), 759 (w), 734 (w), 688 cm^{-1} (m); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 456.8 nm (3.89), 341.5 (4.03), 267.1 (4.56); MS (ESI) *m/z* (%): 1244 ($[3M+Na]^+$, 30), 837 ($[2M+Na]^+$, 100), 430 ($[M+Na]^+$, 30), 408 ($[M+H]^+$, 16).

Procedure 4 (synthesis of heterocycles 6 by reflux): A solution of indolo[1,2-*b*]isoquinolin-5-one (**5b**; 129 mg, 0.34 mmol) in DMSO (20 mL) was stirred at 180 °C and the reaction was monitored by TLC. The color of the reaction mixture turned from red to black. After disappearance of the starting material (ca. 16 h) the solvent was removed in vacuo by bulb-to-bulb-distillation. Chromatographic purification (silica gel, CH_2Cl_2) afforded **6b** as a yellow solid (48 mg, 0.17 mmol, 48%). Spectroscopic data: see below.

Procedure 5 (synthesis of heterocycles 6 by treatment of 5 with HCl: A solution of **5e** (109 mg, 0.29 mmol) in THF (20 mL) was treated with an aqueous solution of HCl (10%, 20 mL) and the solution was stirred at 20 °C for 3–5 days (TLC monitoring). After disappearance of the starting material, an aqueous solution of $NaHCO_3$ was added to the solution. The aqueous layer was extracted with diethyl ether and CH_2Cl_2. The combined organic layers were dried ($MgSO_4$), filtered, and concentrated to give **6e** as a yellow solid (83 mg, 0.29 mmol, 100%). Spectroscopic data: see below.

12-Cyano-5,11-dihydroindolo[1,2-*b*]isoquinolin-5,11-dione (6a): Starting with **5a** (38 mg, 0.11 mmol) (procedure 4), **6a** was obtained as a yellow solid (25 mg, 0.092 mmol, 84%). Procedure 5: 95% yield. ^{1}H NMR (300 MHz, [D$_6$]DMSO): δ = 7.48 (t, ^3J = 7.0 Hz, 1H; Ar), 7.84–7.93 (3 × t, ^3J = 7.6 Hz, ^3J = 8.6 Hz, ^3J = 7.4 Hz, 3H; Ar), 8.00 (d, ^3J = 7.4 Hz, 2H; Ar), 8.41 (d, ^3J = 7.7 Hz, 1H; Ar), 8.55 ppm (d, ^3J = 8.7 Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, [D$_6$]DMSO): δ = 91.11 (C12-CN), 112.84 (CN), 117.51 (CH), 123.17 (C), 125.12, 126.50, 127.11 (CH), 128.15 (C), 128.48, 131.45 (CH), 131.64 (C), 134.85, 137.69 (CH), 138.70, 146.78 (C), 157.68 (C5=O), 180.92 ppm (C11=O); IR (KBr): $\tilde{\nu}$ = 3073 (w), 3035 (w), 2960 (w), 2925 (m), 2228 (m, C≡N), 1713 (s), 1687 (s), 1629 (m), 1599 (s), 1559 (m), 1472 (s), 1460 (s), 1359 (s), 1337 (s), 1327 (s), 1309 (s), 1291 (m), 1196 (m), 1112 (s), 1075 (m), 977 (m), 768 (m), 755 (s), 699 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 350 (510.52), 400 (507.14) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 419.4 nm (3.87), 354.3 (3.78), 328.0 (3.82); MS (EI, 70 eV): *m/z* (%): 272 ($[M]^+$, 100), 244 (8), 215 (10), 189 (4); the exact molecular mass for $C_{17}H_8N_2O_2$ *m/z*: 272.0586 ± 2 mD ($[M]^+$) was confirmed by HRMS (EI, 70 eV); elemental analysis calcd (%) for $C_{17}H_8N_2O_2$ (272.3): C 75.00, H 2.96; found: C 75.30, H 3.24.

Synthesis of 6a from 3f: Starting with **3f** (54 mg, 0.15 mmol) (procedure 4), **6a** was obtained as a yellow solid (40 mg, 0.15 mmol, 94%). Spectroscopic data: see above.

7-Methyl-12-cyano-5,11-dihydroindolo[1,2-*b*]isoquinolin-5,11-dione (6b): Starting with **3g** (93 mg, 0.25 mmol) (procedure 4), **6b** was obtained as a yellow solid (40 mg, 0.14 mmol, 56%). Procedure 5: 82% yield. ^{1}H NMR (300 MHz, [D$_6$]DMSO, *T* = 100 °C): δ = 2.64 (s, 3H; Ar, C7-CH_3), 7.40 (t, ^3J = 7.5 Hz, 1H; Ar, C-9), 7.67 (dd, ^3J = 7.5 Hz, ^4J = 0.8 Hz, 1H; Ar, C-8), 7.73 (dd, ^3J = 7.5 Hz, ^4J = 0.8 Hz, 1H; Ar, C-10), 7.82 (m, 1H; Ar, C-3), 7.97 (td, ^3J = 7.9 Hz, ^4J = 1.1 Hz, 1H; Ar, C-2), 8.36 ppm (dd, ^3J = 7.9 Hz, ^4J = 1.1 Hz, 1H; Ar, C-4); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 22.04 ($ArCH_3$), 91.74 (*C*-CN), 112.29 (C), 122.26 (CH), 124.95 (C), 125.64, 127.04, 128.29 (CH), 128.40, 128.80 (C), 130.87 (CH), 131.19 (C), 134.03 (CH), 139.14 (C), 140.94 (CH), 145.69 (C), 156.89 (C5=O), 180.60 ppm (C11=O); IR (KBr): $\tilde{\nu}$ = 3068 (w), 3035 (w), 2963 (w), 2936 (w), 2228 (w, C≡N), 1716 (s), 1690 (s), 1631 (m), 1598 (m), 1588 (m), 1482 (m), 1455 (m), 1351 (m), 1323 (m), 1305 (s), 1280 (m), 1252 (m), 1246 (m), 1148 (m), 1097 (m), 1065 (m), 1036 (m), 1021 (m), 802 (m), 757 cm^{-1} (m); Fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 335 (539.04) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 422.5 nm (3.80), 332.1 (3.86), 293.2 (3.66); MS (EI, 70 eV): *m/z* (%): 286 ($[M]^+$, 100), 257 (8), 229 (11), 203 (4); the exact molecular mass for $C_{18}H_{10}N_2O_2$ *m/z*: 286.0742 ± 2 mD ($[M]^+$) was confirmed by HRMS (EI, 70 eV).

12-Cyano-9-methyl-5,11-dihydroindolo[1,2-*b*]isoquinolin-5,11-dione (6e): Starting with **5e** (30.0 mg, 80.0 μmol) (procedure 4), **6e** was obtained as a yellow solid (22 mg, 0.075 mmol, 94%). Procedure 5: 100% yield. ^{1}H NMR (250 MHz, $CDCl_3$): δ = 7.57 (d, ^3J = 8.3 Hz, 1H; Ar, C-8), 7.72 (s, 1H; Ar, C-10), 7.77 (t, ^3J = 7.4 Hz, 1H; Ar, C-3), 7.89 (t, ^3J = 7.5 Hz, 1H; Ar, C-2), 8.12 (d, ^3J = 7.7 Hz, 1H; Ar, C-1), 8.53 (d, ^3J = 7.7 Hz, 1H; Ar, C-4), 8.55 ppm (d, ^3J = 8.3 Hz, 1H; Ar, C-7); ^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 21.03 (C9-*C*H_3), 93.12 (C12-CN), 112.32 (CN), 117.98 (C-7), 123.27 (C-10a), 125.60 (C-10), 127.26 (C-1), 128.81 (C-4a), 129.00 (C-4), 131.44 (C-3), 131.88 (C-12a), 134.35 (C-2), 137.58 (C-9), 138.49 (C-8), 145.09 (C-6a), 157.87 (C5=O), 180.64 ppm (C11=O); IR (KBr): $\tilde{\nu}$ = 3069 (w), 3037 (w), 2957 (w), 2923 (m), 2225 (m, C≡N), 1719 (s), 1670 (s), 1634 (m), 1614 (m), 1600 (s), 1484 (s), 1457 (m), 1352 (s), 1335 (s), 1299 (s), 1230 (m), 1168 (m), 1111 (m), 1127 (m), 1081 (m), 838 (m), 766 (s), 688 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 285 (467.62), 395 (546.53) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 425.9 nm (3.57), 360.3 (3.62), 344.0 (3.65); MS (EI, 70 eV): *m/z* (%): 286 ($[M]^+$, 100), 257 (8), 229 (4).

8,10-Dimethyl-12-cyano-5,11-dihydroindolo[1,2-*b*]isoquinolin-5,11-dione (6f): Starting with **5f** (397 mg, 0.98 mmol) (procedure 4), **6f** was obtained as a yellow solid (142 mg, 0.47 mmol, 48%). Procedure 5: 84% yield. ^{1}H NMR (300 MHz, [D$_6$]DMSO, *T* = 100 °C): δ = 2.38 (s, 3H; ArCH_3), 2.62 (s, 3H; ArCH_3), 7.50 (d, ^4J = 0.8 Hz, 1H; Ar, C-7), 7.54 (d, ^4J = 0.8 Hz, 1H; Ar, C-9), 7.82 (m, 1H; Ar, C-3), 7.97 (t, d, ^3J = 7.9 Hz, 2H; Ar, C-3, C-1), 8.38 ppm (ddd, ^3J = 7.9 Hz, ^4J = 1.2 Hz, ^5J = 0.7 Hz, 1H; Ar, C-4); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO, *T* = 100 °C): δ = 81.20 (*C*-CN), 108.15 (C), 112.38 (CN), 122.32 (CH), 125.14 (C), 125.63 (CH), 128.04 (C), 128.29 (CH), 128.86 (C), 130.83, 133.98 (CH), 137.02, 139.39 (C), 141.57 (CH), 143.94 (C), 156.79 (C5=O), 168.80 ppm (C11=O); IR (KBr): $\tilde{\nu}$ = 3074 (w), 3046 (w), 3017 (w), 2962 (w), 2923 (w), 2222 (w, C≡N), 1716 (s), 1692 (s), 1681 (s), 1597 (s), 1481 (s), 1348 (s), 1324 (s), 1303 (s), 1297 (s), 1169 (s), 1099 (m), 1041 (m), 1029 (m), 988 (m), 967 (m), 803 (m), 794 (m), 765 cm^{-1} (s); MS (EI, 70 eV): *m/z* (%): 300 ($[M]^+$, 100), 285 (8), 243 (4); the exact molecular mass for $C_{19}H_{12}N_2O_2$ *m/z*: 300.0899 ± 2 mD ($[M]^+$) was confirmed by HRMS (EI, 70 eV).

9-Methoxy-12-cyano-5,11-dihydroindolo[1,2-*b*]isoquinolin-5,11-dione (6g): Starting with **5g** (26 mg, 0.064 mmol) (procedure 4), **6g** was obtained as an orange solid (13 mg, 0.043 mmol, 67%). Procedure 5: 90% yield. ^{1}H NMR (250 MHz, $CDCl_3$): δ = 3.89 (s, 3H; OCH_3), 7.27 (dd, ^3J = 8.9 Hz, ^4J = 2.7 Hz, 1H; Ar, C-8), 7.27 (d, ^4J = 2.6 Hz, 1H; Ar, C-10), 7.76 (ddd, ^3J = 7.9 Hz, ^3J = 7.4 Hz, ^4J = 1.2 Hz, 1H; Ar, C-2), 7.88 (ddd, ^3J = 7.8 Hz, ^3J = 7.4 Hz, ^4J = 1.5 Hz, 1H; Ar, C-3), 8.10 (dd, ^3J = 7.5 Hz, ^5J = 0.7 Hz, 1H; Ar, C-7), 8.51 (dd, ^3J = 8.0 Hz, ^4J = 1.5 Hz, 1H; Ar, C-1), 8.55 ppm (d, ^3J = 7.9 Hz, ^5J = 1.0 Hz, 1H; Ar, C-4); ^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 56.08 (C9-O*C*H_3), 93.43 (C12-CN), 108.39 (CH), 112.21 (CN), 117.80 (C), 119.42 (CH), 124.47 (C), 124.69, 127.36, 129.01 (CH), 129.09 (C), 131.45 (CH), 132.02 (C), 134.24 (CH), 141.32, 157.55 (C), 159.01 (C5=O), 180.45 ppm (C11=O); IR (KBr): $\tilde{\nu}$ = 3073 (w), 3040 (w), 3002 (w), 2939 (w), 2228 (w, C≡N), 1718 (s), 1671 (s), 1630 (m), 1604 (m), 1486 (s), 1439 (m), 1344 (s), 1290 (m), 1262 (m), 1238 (m), 1199 (m), 1127 (m), 1083 (m), 1028 (m), 835 (w), 802 (w), 769 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 285 (454.96) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 449.0 nm (3.57), 372.9 (3.92), 356.0 (3.94); MS (EI, 70 eV): *m/z* (%): 302 ($[M]^+$, 100), 287 (52), 259 (12), 231 (10), 203 (6); the exact molecular mass for $C_{18}H_{10}N_2O_3$ *m/z*: 302.0691 ± 2 mD ($[M]^+$) was confirmed by HRMS (EI, 70 eV).

Procedure 6 (synthesis of carbolines 7): A solution of **3s**[4a] (321 mg, 1.00 mmol) in DMSO (20 mL) was stirred at 180 °C and the reaction was monitored by TLC. After disappearance of the starting material (ca. 48 h) the solvent was removed in vacuo by bulb-to-bulb-distillation. Chromato-

graphic purification (silica gel, CH_2Cl_2) afforded **7a** as a yellow solid (181 mg, 0.61 mmol, 61 %). Spectroscopic data: see below.

5-Phenyl-6*H*-indolino[3,2-*b*]quinoline (7a): Starting with **3s** (321 mg, 1.00 mmol) (procedure 6), **7a** was obtained as a yellow solid (181 mg, 0.61 mmol, 61 %). ^{1}H NMR (500 MHz, [D$_6$]DMSO): $\delta = 7.28$ (td, $^3J = 8.0$ Hz, $^4J = 1.1$ Hz, 1H; Ar, C-9), 7.50 (tdd, $^3J = 8.0$ Hz, $^4J = 1.3$ Hz, $^5J = 0.6$ Hz, 1H; Ar, C-3), 7.54 (dd, $^3J = 8.0$ Hz, $^4J = 0.9$ Hz, 1H; Ar, C-7), 7.59 (tdd, $^3J = 8.1$ Hz, $^4J = 1.2$ Hz, $^5J = 0.7$ Hz, 1H; Ar, C-8), 7.61 – 7.71 (m, 6H; Ar, Ph, C-2), 7.78 (ddd, $^3J = 8.0$ Hz, $^4J = 1.4$ Hz, $^5J = 0.8$ Hz, 1H; Ar, C-4), 8.26 (ddd, $^3J = 7.8$ Hz, $^4J = 1.2$ Hz, $^5J = 0.6$ Hz, 1H; Ar, C-1), 8.37 (dd, $^3J = 7.4$ Hz, $^5J = 0.7$ Hz, 1H; Ar, C-10), 10.94 ppm (s, 1H; NH); ^{13}C NMR (50.3 MHz, [D$_6$]DMSO): $\delta = 111.83$, 119.40 (CH), 121.09 (C), 121.22, 124.22 (CH), 124.73 (C), 125.05 (CH), 125.24 (C), 125.81, 128.38, 129.04, 129.14, 129.55, 130.16 (CH), 130.32, 134.00, 143.69, 144.40, 145.45 ppm (C); IR (KBr): $\tilde{\nu} = 3053$ (m), 3021 (w), 2961 (w), 2926 (w), 1632 (m), 1614 (m), 1566 (w), 1489 (s), 1472 (m), 1399 (m), 1382 (m), 1338 (m), 1221 (m), 1052 (s), 1027 (s), 1006 (s), 826 (m), 766 (s), 756 (s), 748 (m), 736 (m), 697 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 345 (426.20) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 397.9 nm (3.74), 381.3 (3.69), 340.8 (4.15); UV/Vis ($CHCl_3$): λ_{max} (lg ε) = 396.9 nm (3.54), 380.5 (3.48), 342.7 (3.88); MS (EI, 70 eV): *m*/*z* (%): 294 ([*M*]$^+$, 100), 293 ([*M* − 1]$^+$, 100), 190 (4), 147 (3); the exact molecular mass for $C_{21}H_{14}N_2$ *m*/*z*: 294.1152 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

Procedure 7 (synthesis of 7a by FVP): Product **7a** was prepared from **3s**[4a] by flash-vacuum pyrolysis (FVP). Oven temperature: 550 °C. Vacuum without N_2 flow: 10^{-4} mbar, vacuum with N_2 flow: 10^{-2} – 10^{-3} mbar. Sublimation temperature: 100 – 150 °C. Sublimation time: 1.5 h. Educt input: 430 mg (1.338 mmol). Starting material residue in the sublimation chamber: 353 mg (1.098 mmol). Starting material quantity in reaction: 77.0 mg (0.240 mmol). Chromatographic purification (silica gel, CH_2Cl_2) afforded **7a** as a yellow solid (45 mg, 0.15 mmol, 12 % yield; 64 % yield related to sublimed starting material, 18 % conversion). Spectroscopic data: see above.

1,7-Dimethyl-5-phenyl-6*H*-indolino[3,2-*b*]quinoline (7b): Starting with **3a** (92 mg, 0.26 mmol) (procedure 6), **7b** was obtained as a yellow solid (47 mg, 0.15 mmol, 55 %). ^{1}H NMR (300 MHz, [D$_6$]DMSO, $T = 60$ °C): $\delta =$ 2.53 (ArC*H*$_3$), 2.97 (ArC*H*$_3$), 7.28 (t, $^3J = 7.9$ Hz, 1H; Ar), 7.48 (d, $^3J =$ 7.1 Hz, 2H; Ar), 7.57 (d, $^3J = 7.9$ Hz, 3H; Ar), 7.63 – 7.72 (m, 4H; Ar), 8.55 (d, $^3J = 7.9$ Hz, 1H; Ar), 10.93 ppm (s, 1H; Ar); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO, $T = 60$ °C): 17.03 (Ar*C*H$_3$), 18.32 (Ar*C*H$_3$), 117.76 (C), 120.42, 120.49 (CH), 122.04 (C), 123.37 (CH), 125.03 (C), 125.63, 128.94, 129.04, 129.21, 130.05 (CH), 131.34 (C), 132.26 (CH), 132.44, 132.48, 133.15, 138.11, 141.01, 144.40 ppm (C); IR (KBr): $\tilde{\nu} = 3059$ (w), 3028 (w), 2971 (w), 2921 (w), 1666 (s), 1644 (m), 1611 (m), 1586 (m), 1524 (s), 1502 (m), 1474 (m), 1457 (s), 1395 (m), 1290 (m), 1252 (m), 1218 (m), 1189 (m), 1159 (m), 1040 (m), 824 (w), 754 (s), 728 (m), 709 cm^{-1} (s); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 340 (428.90) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 398.3 nm (3.38), 381.3 (3.33), 343.1 (3.75); MS (ESI): *m*/*z* (%): 324 (20), 323 ([*M*+H]$^+$, 100), 322 ([*M*]$^-$, 10), 321 ([*M* − H]$^-$, 100).

3,9-Dimethyl-5-phenyl-6*H*-indolino[3,2-*b*]quinoline (7c): Starting with **3t**[4a] (45 mg, 0.13 mmol) (procedure 6), **7c** was obtained as a yellow solid (23 mg, 0.07 mmol, 55 %). ^{1}H NMR (250 MHz, [D$_6$]DMSO): $\delta = 2.41$ (s, 3H; C3-C*H*$_3$), 2.49 (s, 3H; C9-C*H*$_3$), 7.40 (2 d, 2H; Ar, C-1, C-7), 7.49 (d, $^3J = 8.6$ Hz, 1H; Ar, C-2), 7.51 (s, 1H; Ar, C-10), 7.59 – 7.63 (m, 3H; Ar, Ph), 7.66 – 7.72 (m, 2H; Ar, Ph), 8.12 (d, $^3J = 8.7$ Hz, 1H; Ar, C-8), 8.14 (s, 1H; Ar, C-4), 10.71 ppm (s, 1H; NH); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO): $\delta =$ 20.85 (Ar*C*H$_3$), 21.47 (Ar*C*H$_3$), 111.48 (C-7), 120.76 (C-4), 121.26 (C-10a), 122.69 (C-10), 124.41 (C), 124.67 (C), 128.00 (C-2), 128.11 (C), 128.24 (C-4′), 128.88 (C-8), 129.00 (C-3′, C-5′), 130.09 (C-2′, C-6′), 130.54 (C-1), 130.76 (C-6a), 134.16 (C-5), 142.22 (C), 142.45 (C), 144.58 ppm (C-10b); IR (KBr): $\tilde{\nu} = 3053$ (m), 3021 (w), 2950 (w), 2919 (m), 2857 (w), 1634 (w), 1611 (w), 1565 (w), 1494 (s), 1442 (m), 1415 (m), 1393 (w), 1329 (m), 1307 (m), 1295 (s), 1254 (m), 1217 (s), 1211 (s), 1133 (w), 1015 (w), 837 (w), 819 (m), 813 (m), 697 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 345 (438.68) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 384.3 nm (3.59), 347.9 (4.09), 280.9 (4.54); MS (EI, 70 eV): *m*/*z* (%): 322 ([*M*]$^+$, 100), 305 (8), 277 (2).

3,9-Dimethyl-5-(3-tolyl)-6*H*-indolino[3,2-*b*]quinoline (7d): Starting with **3q** (131 mg, 0.36 mmol) (procedure 6), **7d** was obtained as a yellow solid (76 mg, 0.23 mmol, 63 %). ^{1}H NMR (300 MHz, [D$_6$]DMSO, $T = 100$ °C): $\delta = 2.41$ (s, 3H; ArC*H*$_3$), 2.45 (s, 3H; ArC*H*$_3$), 2.49 (s, 3H; ArC*H*$_3$), 7.34 – 7.52 (m, 6H; Ar), 7.55 (s, t, 2H; Ar), 8.12 (s, d, 2H; Ar), 10.35 ppm (br s, 1H; NH); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO): $\delta = 20.29$ (Ar*C*H$_3$), 20.55 (Ar*C*H$_3$), 20.90 (Ar*C*H$_3$), 111.05, 120.28 (CH), 121.23 (C), 122.41 (CH), 124.25, 124.48 (C), 126.70, 127.40 (CH), 127.72 (C), 128.32, 128.37, 128.48, 129.94, 130.10 (CH), 130.53, 133.54, 133.89, 137.80, 142.08, 142.18, 144.37 ppm (C); IR (KBr): $\tilde{\nu} = 3049$ (m), 3023 (m), 2965 (m), 2917 (m), 2859 (w), 1636 (m), 1612 (w), 1604 (w), 1562 (w), 1492 (s), 1443 (m), 1414 (m), 1329 (m), 1306 (m), 1295 (s), 1255 (m), 1211 (s), 1211 (s), 1136 (w), 1129 (w), 815 (m), 809 (m), 794 (w), 783 cm^{-1} (w); UV/Vis (CH_3CN): λ_{max} (lg ε) = 400.7 nm (3.78), 386.4 (3.77), 347.8 (4.27); MS (EI, 70 eV): *m*/*z* (%): 336 ([*M*]$^+$, 100), 320 (8), 305 (4); the exact molecular mass for $C_{24}H_{20}N_2$ *m*/*z*: 336.1626 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

1,3,7,9-Tetramethyl-5-phenyl-6*H*-indolino[3,2-*b*]quinoline (7e): Starting with **3u**[4b] (66 mg, 0.18 mmol) (procedure 6), **7e** was obtained as a yellow solid (47 mg, 0.13 mmol, 76 %). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.44$ (s, 6H; C3-C*H*$_3$, C7-C*H*$_3$), 2.54 (s, 3H; C9-C*H*$_3$), 3.03 (s, 3H; C1-C*H*$_3$), 7.18 (s, 1H; Ar, C-8), 7.38 (s, 1H; Ar, C-2), 7.44 (s, 1H; Ar, C-4), 7.46 (br s, 1H; NH), 7.58 – 7.70 (m, 5H; Ar, Ph), 8.23 ppm (s, 1H; Ar, C-10); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 16.51$ (C7-*C*H$_3$), 18.78 (C1-*C*H$_3$), 21.19 (C9-*C*H$_3$), 21.88 (C3-*C*H$_3$), 119.42 (C-7), 119.47 (C-10), 121.29 (C-4), 122.60 (C-4a), 125.11 (C-5), 128.35 (C-4′), 128.93 (C-2), 129.23 (C-2′, C-6′), 129.60 (C-5a), 130.11 (C-3′, C-5′), 130.71 (C-9), 131.31 (C-8), 134.42 (C-3), 135.07 (C-1′), 136.75 (C-1), 140.63 (C-6a), 142.25 (C-11a), 144.09 (C-10b), 145.15 ppm (C-10a); IR (KBr): $\tilde{\nu} = 3055$ (w), 3021 (w), 2992 (w), 2964 (m), 2946 (m), 2920 (s), 1734 (w), 1631 (m), 1616 (m), 1600 (m), 1491 (s), 1453 (m), 1399 (m), 1386 (m), 1375 (m), 1362 (m), 1324 (m), 1297 (s), 1199 (s), 1031 (m), 856 (s), 803 (m), 772 (m), 703 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 350 (447.97) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 401.1 nm (3.67), 385.3 (3.69), 350.2 (4.17); MS (EI, 70 eV): *m*/*z* (%): 350 ([*M*]$^+$, 100), 335 (4), 296 (8).

2,4,8,10-Tetramethyl-5-(4-tolyl)-6*H*-indolino[3,2-*b*]quinoline (7f): Starting with **3r** (128 mg, 0.33 mmol) (procedure 6), **7f** was obtained as a yellow solid (96 mg, 0.26 mmol, 80 %). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.45$ (s, 6H; ArC*H*$_3$), 2.55 (s, 6H; ArC*H*$_3$), 3.03 (s, 3H; ArC*H*$_3$), 7.19 (s, 1H; Ar), 7.38 (s, 1H; Ar), 7.44 – 7.54 (m, 6H; Ar + NH), 8.21 ppm (s, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 16.79$ (Ar*C*H$_3$), 19.04 (Ar*C*H$_3$), 21.49 (Ar*C*H$_3$), 21.70 (Ar*C*H$_3$), 22.17 (Ar*C*H$_3$), 119.57 (CH), 119.68 (C), 121.65 (CH), 123.12, 125.54 (C), 129.00 (CH), 129.73 (C), 130.20, 130.26 (CH), 131.09 (C), 131.41 (CH), 132.35, 134.49, 135.79, 137.17, 138.38, 140.86, 142.94, 144.73 ppm (C); IR (KBr): $\tilde{\nu} = 3052$ (w), 3014 (w), 2963 (m), 2943 (m), 2917 (s), 2859 (w), 1686 (m), 1517 (s), 1499 (s), 1491 (s), 1468 (m), 1448 (m), 1385 (m), 1374 (m), 1296 (s), 1199 (s), 1035 (w), 856 (m), 827 (m), 801 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 395 (444.19) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 401.1 nm (3.67), 386.1 (3.67), 350.0 (4.22); MS (EI, 70 eV): *m*/*z* (%): 364 ([*M*]$^+$, 16), 296 (44), 148 (16), 121 (100); the exact molecular mass for $C_{24}H_{20}N_2$ *m*/*z*: 364.1939 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

1,7-Dimethyl-5-(4-methoxyphenyl)-6*H*-indolino[3,2-*b*]quinoline (7g): Starting with **3o** (55 mg, 0.14 mmol) (procedure 6), **7g** was obtained as a yellow solid (37 mg, 0.10 mmol, 71 %). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta =$ 2.49 (s, 3H; ArC*H*$_3$), 3.05 (s, 3H; ArC*H*$_3$), 3.94 (s, 3H; OC*H*$_3$), 7.16 (d, $J =$ 8.7 Hz, 2H; C-3′, C-5′, AA′ Ar), 7.26 (t, $^3J = 7.5$ Hz, 1H; Ar), 7.37 (d, $J =$ 6.7 Hz, 2H; Ar), 7.54 (t, d (XX′), $J = 8.6$ Hz, 3H; Ar), 7.65 (br, 1H; NH), 7.74 (d, $^3J = 8.1$ Hz, 1H; Ar), 8.42 ppm (d, $^3J = 7.6$ Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 16.56$ (Ar*C*H$_3$), 18.84 (Ar*C*H$_3$), 55.40 (O*C*H$_3$), 114.68, 119.70 (CH), 119.81 (C), 120.15 (CH), 122.63 (C), 122.74, 124.67 (CH), 125.40, 125.89 (C), 126.34 (CH), 126.84 (C), 129.94 (CH), 130.43 (C), 131.26 (CH), 137.32, 142.50, 144.08, 145.17, 159.66 ppm (C); IR (KBr): $\tilde{\nu} =$ 3065 (w), 3020 (w), 2964 (w), 2941 (w), 2918 (m), 1628 (m), 1606 (m), 1517 (m), 1501 (s), 1474 (m), 1444 (m), 1391 (s), 1366 (m), 1315 (m), 1286 (m), 1242 (s), 1214 (m), 1185 (s), 1067 (m), 1023 (s), 833 (m), 824 (m), 765 (s), 747 cm^{-1} (s); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 340 (427.33) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 399.4 nm (3.77), 382.4 (3.73), 343.4 (4.15); MS (EI, 70 eV): *m*/*z* (%): 352 ([*M*]$^+$, 100), 307 (6), 176 (4); the exact molecular mass for $C_{24}H_{20}N_2O$ *m*/*z*: 352.1576 ± 2 mD ([*M*]$^+$) was confirmed by HRMS (EI, 70 eV).

Synthesis of 7g from 10: Starting with **10**[4b] (73 mg, 0.16 mmol) (procedure 6), **7g** was obtained as a yellow solid (30 mg, 0.085 mmol, 53 %); Spectroscopic data: see above.

3,9-Dimethyl-5-(3-methoxyphenyl)-6*H*-indolino[3,2-*b*]quinoline (7h): Starting with **3n** (113 mg, 0.30 mmol) (procedure 6), **7h** was obtained as

a yellow solid (34 mg, 0.10 mmol, 32%). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta =$ 2.49 (s, 3H; ArCH_3), 2.54 (s, 3H; ArCH_3), 3.86 (s, 3H; OCH_3), 7.08 (t, $^3J =$ 8.2 Hz, 1H; Ar), 7.10 (t, $^3J = 8.1$ Hz, 1H; Ar), 7.16 (d, $^3J = 7.6$ Hz, 1H; Ar), 7.27 (d, $^3J = 6.8$ Hz, 1H; Ar), 7.36 (dd, $^3J = 8.1$ Hz, $^4J = 1.5$ Hz, 1H; Ar), 7.48 (dd, $^3J = 6.8$ Hz, $^4J = 1.9$ Hz, 1H; Ar), 7.52 (t, $^3J = 8.0$ Hz, 1H; Ar), 7.63 (s, 1H; Ar), 7.95 (br s, 1H; NH), 8.25 (d, $^3J = 8.7$ Hz, 1H; Ar), 8.33 ppm (d, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 21.26$ (ArCH_3), 21.92 (ArCH_3), 55.39 (OCH_3), 21.70 (ArCH_3), 22.17 (ArCH_3), 110.50, 114.02, 115.45, 121.93, 122.32 (CH), 122.55 (C), 123.26 (CH), 124.96, 125.13 (C), 128.69, 129.17 (CH), 129.67 (C), 130.34, 130.76 (CH), 131.04, 135.03, 135.97, 141.48, 143.28, 145.09, 160.16 ppm (C); IR (KBr): $\tilde{\nu} = 3051$ (w), 3024 (w), 2963 (m), 2918 (m), 2856 (m), 1652 (m), 1614 (m), 1597 (s), 1588 (s), 1492 (s), 1460 (s), 1427 (m), 1391 (m), 1330 (m), 1293 (s), 1255 (s), 1246 (s), 1209 (s), 1133 (m), 1034 (m), 816 (m), 800 (m), 762 (w), 701 cm^{-1} (w); UV/Vis (CH_3CN): λ_{max} (lg ε) = 400.6 nm (3.72), 386.9 (3.72), 347.9 (4.20); MS (EI, 70 eV): m/z (%): 352 ([M]$^+$, 100), 337 (6), 293 (4); the exact molecular mass for $C_{24}H_{20}N_2O$ m/z: 352.1576 ± 2 mD ([M]$^+$) was confirmed by HRMS (EI, 70 eV).

1,7-Dimethoxy-5-phenyl-6*H*-indolino[3,2-*b*]quinoline (7i): Starting with **3v**[4b] (83 mg, 0.22 mmol) (procedure 6), **7i** was obtained as a yellow solid (59 mg, 0.17 mmol, 77%). ^{1}H NMR (300 MHz, [D$_6$]DMSO): $\delta = 3.93$ (s, 3H; OCH_3), 4.04 (s, 3H; OCH_3), 7.07 (d, $^3J = 7.3$ Hz, 1H; Ar), 7.17 (d, $^3J =$ 8.0 Hz, 2H; Ar), 7.23 (t, $^3J = 7.7$ Hz, 1H; Ar), 7.35 (t, $^3J = 7.7$ Hz, 1H; Ar), 7.50–7.63 (m, 5H; Ph), 7.95 (d, $^3J = 7.0$ Hz, 1H; Ar), 10.75 ppm (s, 1H; NH); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO): $\delta = 55.47$ (OCH_3), 55.59 (OCH_3), 104.72, 110.13, 113.32, 116.26, 120.21 (CH), 122.93 (C), 124.88 (CH), 126.07, 126.48 (C), 128.06, 128.67, 130.19 (CH), 130.67, 134.23, 134.30, 135.96, 144.18, 145.97, 155.47 ppm (C); IR (KBr): $\tilde{\nu} = 3064$ (w), 3030 (w), 2932 (w), 2831 (w), 1633 (m), 1609 (m), 1588 (m), 1508 (s), 1491 (s), 1478 (s), 1443 (m), 1391 (s), 1350 (m), 1319 (m), 1257 (s), 1216 (m), 1174 (m), 1109 (s), 1079 (m), 1023 (m), 816 (w), 758 (s), 728 (m), 714 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 400 (553.52) nm; UV/Vis (DMF): λ_{max} (lg ε) = 403.4 nm (3.81), 387.1 (3.78), 346.5 (4.05); MS (EI, 70 eV): m/z (%): 354 ([M]$^+$, 100), 337 (12), 325 (36), 309 (26), 279 (4).

5-(4-Bromophenyl)-6*H*-indolino[3,2-*b*]quinoline (7j): Starting with **3c** (38 mg, 0.09 mmol) (procedure 6), **7j** was obtained as an orange solid (17 mg, 0.05 mmol, 48%). Product **8** (15 mg, 0.05 mmol, 49%) was isolated as a second product. Spectroscopic data for **8**: see below. ^{1}H NMR (300 MHz, [D$_6$]DMSO): $\delta = 7.30$ (t, 1H; Ar), 7.48 (d, t, 2H; Ar), 7.56 (d, 2H; AA′, Ar), 7.58 (t, 1H; Ar), 7.63 (td, 1H; Ar), 7.75 (d, 1H; Ar), 7.84 (d, 2H; XX′, Ar), 8.23 (d, 1H; Ar), 8.37 (d, 1H; Ar), 10.91 ppm (br, 1H; NH); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO): $\delta = 111.70$, 119.43 (CH), 121.02 (C), 121.23 (CH), 121.88, 123.87 (C), 123.93 (CH), 124.43 (C), 125.19, 125.84, 129.15, 129.61 (CH), 130.30 (C), 131.98, 132.34 (CH), 133.22, 143.57, 144.36, 145.47 ppm (C); IR (KBr): $\tilde{\nu} = 3062$ (w), 3020 (w), 2955 (m), 2923 (s), 2853 (s), 1712 (m), 1627 (m), 1614 (s), 1606 (s), 1484 (s), 1470 (m), 1397 (m), 1383 (m), 1338 (m), 1219 (m), 1143 (m), 1072 (m), 1011 (s), 832 (m), 771 (w), 753 (s), 747 cm^{-1} (s); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 340 (428.96) nm; UV/Vis (DMF): λ_{max} (lg ε) = 486.3 nm (3.09), 404.9 (3.39), 343.7 (3.82); MS (EI, 70 eV): m/z (%): 374 ([M]$^+$, ^{81}Br isotope, 43), 373 ([M]$^+$, ^{79}Br isotope, 43), 326 (64), 324 (62), 245 (100), 216 (8), 190 (16).

(*E*)-2-[1-Cyano-1-(4-bromophenyl)methylidene]-3-oxo-2,3-dihydro-1*H*-indole (8): ^{1}H NMR (300 MHz, [D$_6$]DMSO, $T = 50\,^\circ$C): $\delta = 6.97$ (d, $^3J =$ 7.4 Hz, 1H; Ar, C-7), 7.09 (t, $^3J = 7.1$ Hz, 1H; Ar, C-5), 7.58 (d, $^3J = 8.7$ Hz, 2H; AA′, Ar, C-2′, C-6′), 7.60 (t, $^3J = 7.0$ Hz, 1H; Ar, C-6), 7.65 (d, $^3J =$ 7.6 Hz, 1H; Ar, C-4), 7.77 (d, $^3J = 8.7$ Hz, 2H; XX′, Ar, C-3′, C-5′), 10.41 ppm (br, 1H; NH); ^{13}C NMR (75.5 MHz, [D$_6$]DMSO): $\delta = 87.50$ (*C*-CN), 112.57 (C-5), 117.49 (CN), 119.38 (C-3a), 121.53 (C-7), 122.25 (C-7a), 124.84 (C-4), 130.81 (C-2′, C-6′), 131.30 (C-1′), 132.16 (C-3′, C-5′), 137.45 (C-6), 142.78 (C-2), 152.29 (C-4′), 184.02 ppm (C=O); IR (KBr): $\tilde{\nu} = 3064$ (w), 3057 (w), 2923 (w), 2211 (m, C≡N), 1712 (s), 1624 (s), 1602 (s), 1483 (s), 1467 (s), 1407 (m), 1333 (s), 1311 (m), 1239 (m), 1215 (s), 1147 (m), 1085 (m), 1009 (s), 879 (w), 833 (w), 746 (s), 716 cm^{-1} (w); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 395 (422.58) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 479.9 nm (3.74), 322.0 (3.96), 275.8 (4.33); MS (EI, 70 eV): m/z (%): 326 ([M]$^+$, ^{81}Br isotope, 56), 324 ([M]$^+$, ^{79}Br isotope, 56), 245 (100), 216 (8), 190 (16); the exact molecular mass for $C_{16}H_9N_2O^{79}Br$ m/z: 323.9898 ± 2 mD ([M]$^+$) was confirmed by HRMS (EI, 70 eV).

5-(4-Bromophenyl)-1,7-dimethyl-6*H*-indolino[3,2-*b*]quinoline (7k): Starting with **3b** (88 mg, 0.20 mmol), **7k** was isolated as a yellow solid (58 mg, 0.14 mmol, 71%). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.49$ (s, 3H; ArCH_3), 3.04 (s, 3H; ArCH_3), 7.26 (t, $^3J = 7.7$ Hz, 1H; Ar), 7.38 (2 × d, $^3J = 7.1$ Hz, 2H; Ar), 7.48–7.56 (t, d (AA′) + s, 4H; 3 × Ar, NH), 7.63 (d, $^3J = 8.4$ Hz, 1H; Ar), 7.77 (d, $^3J = 8.3$ Hz, 2H; XX′, Ar), 8.41 ppm (d, $^3J = 7.7$ Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 16.57$ (ArCH_3), 18.81 (ArCH_3), 119.72 (CH), 119.92 (C), 120.39, 122.27 (CH), 122.53, 122.75, 124.53, 124.79 (C), 125.05, 126.50 (CH), 129.99 (C), 130.15, 131.81, 132.52 (CH), 133.82, 137.50, 142.53, 143.94, 145.31 ppm (C); IR (KBr): $\tilde{\nu} = 3051$ (w), 3021 (w), 2957 (w), 2917 (m), 1613 (m), 1592 (m), 1500 (s), 1487 (s), 1474 (s), 1390 (s), 1378 (s), 1314 (s), 1241 (m), 1213 (s), 1188 (m), 1165 (m), 1063 (w), 1014 (s), 836 (m), 819 (w), 755 (s), 747 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 345 (434.47) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 399.6 nm (3.86), 383.2 (3.82), 343.9 (4.24); MS (EI, 70 eV): m/z (%): 402 ([M]$^+$, ^{81}Br isotope, 100), 400 ([M]$^+$, ^{79}Br isotope, 98), 321 (10), 306 (8), 160 (10); the exact molecular mass for $C_{23}H_{17}N_2{}^{79}Br$ m/z: 400.0575 ± 2 mD ([M]$^+$) was confirmed by HRMS (EI, 70 eV).

1,7-Dimethyl-5-(4-methyloxycarbonylphenyl)-6*H*-indolino[3,2-*b*]quinoline (7l): Starting with **3h** (106 mg, 0.26 mmol), **7l** was isolated as a yellow solid (40 mg, 0.11 mmol, 40%). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 2.49$ (s, 3H; ArCH_3), 3.04 (s, 3H; ArCH_3), 4.00 (s, 3H; CO_2CH_3), 7.26 (t, $^3J =$ 7.7 Hz, 1H; Ar), 7.29 (t, $^3J = 7.9$ Hz, 1H; Ar), 7.38 (d, $^3J = 7.1$ Hz, 1H; Ar), 7.53 (d, $^3J = 6.8$ Hz, 1H; Ar), 7.61 (d, $^3J = 8.4$ Hz, 1H; Ar), 7.71 (d, $^3J =$ 8.2 Hz, 2H; AA′, Ar), 7.75 (s, 1H; NH), 8.29 (d, $^3J = 8.2$ Hz, 2H; XX′, Ar), 8.41 ppm (d, $^3J = 7.8$ Hz, 1H; Ar); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 16.57$ (ArCH_3), 18.81 (ArCH_3), 18.81 (CO_2CH_3), 119.75 (CH), 120.00 (C), 120.43, 122.25 (CH), 122.42, 124.61, 124.74 (C), 125.15, 126.57 (CH), 129.93, 130.19 (C), 130.24, 130.30, 130.47 (CH), 137.51, 139.89, 142.63, 143.83, 145.35 (C), 166.69 ppm (C=O); IR (KBr): $\tilde{\nu} = 3060$ (w), 3041 (w), 2948 (w), 2920 (w), 1711 (s), 1612 (s), 1500 (m), 1474 (m), 1437 (m), 1395 (s), 1370 (m), 1316 (m), 1289 (s), 1279 (s), 1217 (m), 1190 (m), 1119 (m), 1021 (m), 776 (m), 763 (m), 750 (m), 724 cm^{-1} (m); UV/Vis (CH_3CN): λ_{max} (lg ε) = 399.9 nm (3.81), 344.1 (4.14), 276.3 (4.70); MS (EI, 70 eV): m/z (%): 380 ([M]$^+$, 100), 321 ([$M - CO_2Me$]$^+$, 12), 305 (6); the exact molecular mass for $C_{25}H_{20}N_2O_2$ m/z: 380.1525 ± 2 mD ([M]$^+$) was confirmed by HRMS (EI, 70 eV).

(1*Z*,2*Z*)-1,2-Bis(2′-oxocumaran-3′-ylidene)-1,2-bis(phenylamino)ethane (14): The reaction (procedure 3) of 2-cumaranone (148 mg, 1.10 mmol) and oxalic acid bis(phenylimidoyl) dichloride (**2b**; 277 mg, 1.00 mmol) afforded **14** as a yellow solid (55 mg, 12%). ^{1}H NMR (250 MHz, $CDCl_3$): $\delta = 6.85$–7.00 (m, 6H; Ar), 7.05–7.21 (m, 12H; Ar), 10.83 ppm (s, 2H; NH); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 93.69$ (*C*-CO), 110.46, 118.80 (CH), 122.22 (CH, Ph), 122.29 (C), 124.12, 126.09, 126.68 (CH), 129.42 (CH, Ph), 136.50, 146.26, 150.19 (C), 170.60 ppm (C=O); IR (KBr): $\tilde{\nu} = 3057$ (w), 2925 (w), 1711 (s), 1614 (s), 1596 (s), 1575 (s), 1497 (m), 1455 (m), 1439 (m), 1329 (m), 1296 (m), 1246 (s), 1146 (s), 1128 (s), 1087 (s), 1022 (w), 985 (w), 973 (w), 861 (w), 784 (m), 751 (m), 692 cm^{-1} (m); UV/Vis (CH_3CN): λ_{max} (lg ε) = 389.9 nm (4.37), 248.3 (4.30), 229.6 (4.30); MS (ESI): m/z (%): 966 ([2M+Na]$^+$, 80), 965 ([2M − H]$^-$, 30), 910 (36), 854 (50), 829 (20), 729 (16), 495 ([M+Na]$^+$, 20), 472 ([M]$^-$, 30), 471 ([M]$^-$, 100).

Procedure 8 (synthesis of indirubine derivatives 15): BBr_3 (1M solution in CH_2Cl_2, 2.04 mL, 2.04 mmol) was added to a solution of (*E*)-2-[1-cyano-1-(2-methoxyphenyl)methylidene]-7-methyl-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (**3k**; 193 mg, 0.51 mmol) in CH_2Cl_2 (10 mL) at 0 °C. The color of the reaction mixture changed from orange to deep violet. The mixture was stirred and warmed to room temperature overnight. The solution was poured into an aqueous solution of potassium *tert*-butanolate (10 mL, 1M). After extraction of the aqueous layer (3 × CH_2Cl_2) the combined organic layers were dried (Na_2SO_4) and the solvent was removed in vacuo. Chromatographic purification (silica gel; petroleum ether/diethyl ether = 30:1) afforded **15b** as a violet solid (99 mg, 0.27 mmol, 53%).

Synthesis of (2*E*)-7-Methyl-2-(2′-oxocumaran-3′-ylidene)-3-(2-tolyl)imino-2,3-dihydro-1*H*-indole (15b): ^{1}H NMR (250 MHz, [D$_6$]DMSO): $\delta = 2.07$ (s, 3H; ArCH_3), 2.37 (s, 3H; ArCH_3), 6.07 (d, $^3J = 7.4$ Hz, 1H; Ar), 6.61 (t, $^3J = 7.6$ Hz, 1H; Ar), 6.94 (d, $^3J = 7.4$ Hz, 1H; Ar), 7.10–7.23 (m, 4H; Ar), 7.28–7.40 (m, 3H; Ar), 8.58 (d, $^3J = 7.4$ Hz, 1H; Ar), 9.70 ppm (s, 1H; NH); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta = 15.51$ (ArCH_3), 17.16 (ArCH_3), 89.30 (*C*-CO), 108.95, 117.38 (CH), 119.23 (C), 122.61, 122.77, 122.82, 123.20, 123.47, 125.21 (CH), 125.38, 126.47 (C), 127.03 (CH), 127.32 (C), 130.82, 135.12 (CH), 148.02, 150.70 (C), 164.68 ppm (C=O); IR (KBr): $\tilde{\nu} = 2924$ (w), 1726 (w), 1690 (w), 1648 (m), 1626 (s), 1605 (s), 1595 (s), 1575 (s), 1524 (m), 1483 (m), 1457 (s), 1434 (m), 1302 (m), 1291 (m), 1230 (m), 1205 (m), 1184 (m), 1153 (m), 1095 (w), 1064 (w), 752 cm^{-1} (s); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 340 (418.46) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 538.2 nm (3.75),

291.0 (4.13), 271.4 (4.11); MS (EI, 70 eV): m/z (%): 365 ($[M]^+$, 64), 348 (44), 259 (100), 182 (4).

(2*E*)-8-Methyl-2-(2′-oxocumaran-3′-ylidene)-3-(3-tolyl)imino-2,3-dihydro-1*H*-indole (15c): Starting with **3l** (70 mg, 0.18 mmol) (procedure 8), **15c** was obtained as a violet solid (22 mg, 0.06 mmol, 33%). ^{1}H NMR (250 MHz, [D$_6$]DMSO): $\delta = 2.31$ (s, 3H; ArCH_3), 2.41 (s, 3H; ArCH_3), 6.47 (s, 1H; Ar), 6.48 (s, 1H; Ar), 6.85 (d, $^3J = 8.4$ Hz, 3H; Ar), 7.08 (t, d, $^3J = 7.9$ Hz, 3H; Ar), 7.20 (dd, $^3J = 7.7$ Hz, $^4J = 1.2$ Hz, 1H; Ar), 7.35 (t, $^3J = 7.7$ Hz, 1H; Ar), 8.90 ppm (d, 1H; NH); ^{13}C NMR (50.3 MHz, $CDCl_3$): $\delta =$ 20.67 (Ar*C*H$_3$), 21.31 (Ar*C*H$_3$), 81.50 (*C*-CO), 111.44, 114.57, 116.35, 118.09 (CH), 118.37 (C), 119.30 (CH), 119.74 (C), 120.63 (CH), 123.04 (C), 124.41, 125.14 (CH), 128.28 (C), 128.97, 129.59, 130.62 (CH), 138.64, 144.07, 149.14, 150.61, 154.93 (C), 165.78 ppm (C=O); IR (KBr): $\tilde{\nu} = 2954$ (m), 2923 (s), 2853 (m), 1652 (m), 1629 (s), 1607 (s), 1598 (s), 1576 (s), 1523 (w), 1457 (s), 1330 (m), 1300 (m), 1229 (m), 1176 (m), 1146 (s), 1095 (m), 1061 (m), 794 (m), 755 (m), 749 cm^{-1} (m); fluorescence (CH_3CN) Ex ($F\lambda_{max}$): 340 (426.02) nm; UV/Vis (CH_3CN): λ_{max} (lg ε) = 531.1 nm (3.76), 290.4 (4.20); MS (ESI): m/z (%): 366 ($[M+H]^+$, 100), 365 ($[M]^-$, 54), 364 ($[M-H]^-$, 100).

Materials and methods for DNA intercalation experiments: A 35mer oligonucleotide GAAAGAAGCGTTTTCGCTTCTTTCTTTTCTTTCTT, capable of forming triple- and double-helical structures by folding back on itself under suitable conditions, was used for the UV studies. UV thermal melting profiles were obtained with a Kontron Uvikon 922 spectrophotometer equipped with a Peltier element. Readings of absorbance A at 260 nm versus temperature T were recorded with a heating rate of 0.5 °C min^{-1} controlled by home-written software. Measurements were performed in 200 mM NaCl and 10 mM PIPES buffer, pH 7.0, on the olignucleotide in the absence and presence of the polycyclic compound using quartz cuvettes of 1 cm optical path length. Prior to each melting experiment the samples were annealed by heating to 90 °C for 5 min followed by slow cooling to room temperature. Because of hysteresis effects on successive heating and cooling cycles, melting temperatures T_m were taken as the temperature for half-dissociation of the DNA triplex or duplex upon heating and were determined from the first derivative plot dA/dT versus temperature.

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