A reductive Mizoroki-Heck approach to dibenzo[*b*,*e*]oxepine

K.C. Majumdar, Tapas Ghosh, Sudipta Ponra

PII: S0040-4039(13)01037-X
DOI: http://dx.doi.org/10.1016/j.tetlet.2013.06.070
Reference: TETL 43123

To appear in: *Tetrahedron Letters*

Please cite this article as: Majumdar, K.C., Ghosh, T., Ponra, S., A reductive Mizoroki-Heck approach to dibenzo[*b*,*e*]oxepine, *Tetrahedron Letters* (2013), doi: http://dx.doi.org/10.1016/j.tetlet.2013.06.070

A reductive Mizoroki-Heck approach to dibenzo[*b*,*e*]oxepine

K. C. Majumdar,* Tapas Ghosh, Sudipta Ponra

Department of Chemistry, University of Kalyani, Kalyani-741235, W.B., India.

Abstract: The synthesis of dibenzo[*b*,*e*]oxepine framework via palladium-mediated reductive Mizoroki-Heck reaction has been described. The procedure is simple, straightforward and regioselective.

Keywords: Dibenzo[*b*,*e*]oxepine, Reductive Mizoroki-Heck cyclization, tetrakis(triphenylphosphine)palladium(0), 2-bromobenzylbromide, Sonogashira coupling

*Corresponding author: Tel (O): +91-3712-267008, Fax: (O): +91-3712-267005 E-mail: kcm@klyuniv.ac.in

A wide range of natural products possess a seven-membered oxepin ring in their molecular architecture.[1] Moreover, this unit serves as target molecules in numerous synthetic studies.[2] The benz[*b*]oxepine ring system occurs in a small number of biologically active natural products isolated mainly from plant sources.[3] Some of these compounds exhibit oral hypotensive and antiulcer properties.[4] Few medicinally as well as pharmacogenically important compounds bearing benzoxepin skeleton are shown in Figure **1**. Recently, pacharin (**1**) and bauhiniastatins 4 (**2**) were isolated from the plant Bauhinia purpurea, and these compounds were shown to significantly inhibit cancer cell growth.[5] These compounds are similar to the natural products bauhinoxepin B (**6**)[6] which have been shown to exhibit anti-mycobacterial activity. CGP 3466 (**5**) exhibits strong neuroprotective activity as the result of its ability to prevent neuronal apoptosis in the adult brain.[7] Asakawa *et al*. first isolated radulanins H (**3**)[8] and E (**4**),[9] from the liverwort *Radula perrottetii* and *Radula variabilis*. They are 3-methyl-2,5-dihydro-1-benzoxepin derivatives.[10] It has been reported that radulanin H (**3**) exhibits important calmodulin and cyclooxygenase inhibitory actions.[11] The fungal metabolites pterulone (**7**)[12] prevents the eukaryotic respiratory chain at the NADH site of the ubiquinone oxidoreductase, possesses potent antifungal activity and is only weakly cytotoxic. Therefore, the syntheses of these units carrying different functionalities are important.

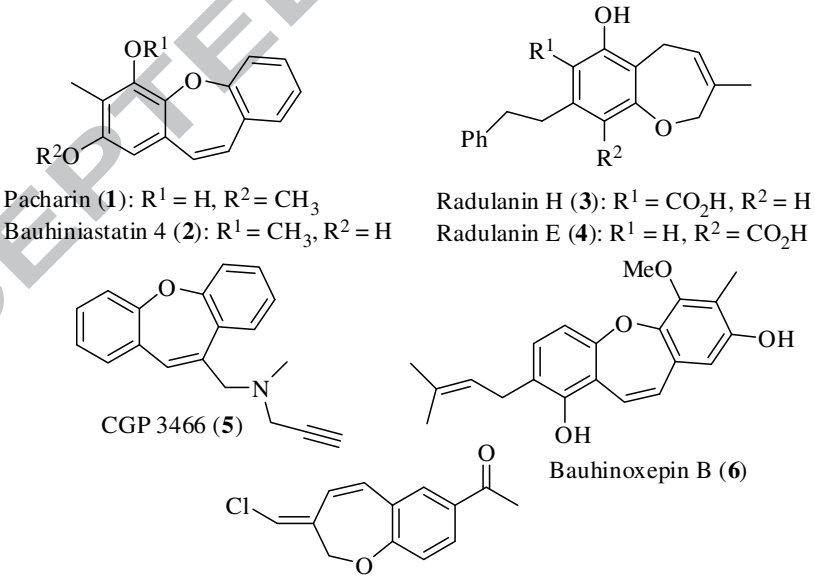
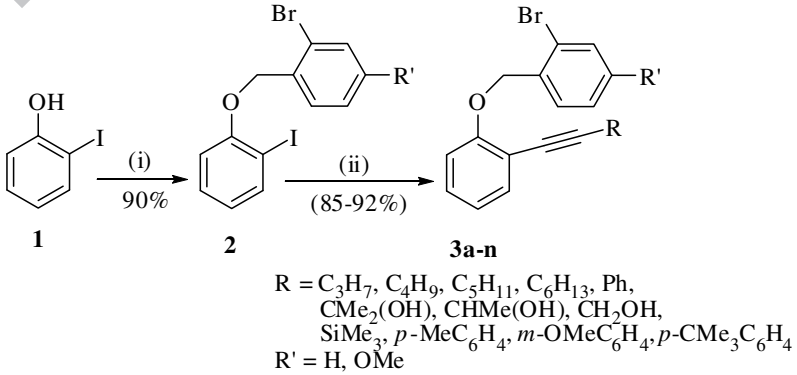


Figure 1: Benzoxepine moiety in natural and medicinal compounds.

The scope of conventional cyclization strategies to medium-sized rings is limited by unfavorable entropy factors, enthalpy factors, transannular interaction and lack of functional diversity of the reaction products.[13] Many synthetic methods, including RCM (Ring-Closing Metathesis)[14] and transition-metal-mediated cyclizations,[15] have been utilized for the construction of medium-ring heterocycles, especially oxepine derivatives. Recently we have successfully synthesized medium-ring heterocycles based on a sulfanyl radical addition and cyclization procedure.[16] However, sometimes these methods suffer from complex reaction conditions, difficulty in separation of products and also from the toxicity of thiophenol. We have also previously developed routes to benzoxepine derivatives based on intramolecular iodocyclization reaction and intramolecular Heck reaction.[17, 18] The reductive Mizoroki-Heck reaction has rapidly gained acceptance as a key tactic in the construction of a wide range of carbo- and heterocyclic ring systems.[19] Literature search revealed that reductive Mizoroki-Heck cyclization has not yet been explored for the construction of benzoxepine moiety. The reductive Mizoroki-Heck reaction may provide an alternative and easy procedure for the construction of some benzoxepine skeletons, which are present as a basic structural moiety in a number of naturally occurring compounds. This has prompted us to investigate the reductive Mizoroki-Heck reaction for the synthesis of dibenzoxepine skeleton. Herein we report the results.

The precursors **3a-n** for our present study were synthesized in good to excellent yields by the Sonogashira cross coupling reaction of iodide **2** with appropriate alkynes as depicted in Scheme **1**. The iodo compound **2** was in turn prepared from easily available 2-iodophenol and 2-bromobenzylbromide (or 2-bromo-4-methoxy-benzylbromide) by refluxing in anhydrous acetone in the presence of K_2CO_3 for 4h in 90% yield.



Scheme 1: Preparation of the starting materials: *Reagents and conditions*: (i) 2-bromobenzylbromide/2-bromo-4-methoxy-benzylbromide, acetone, K_2CO_3, reflux, 4h; (ii) Alkyne, $Pd(PPh_3)_2Cl_2$, CuI, DMF, Et_3N, r.t., 4h

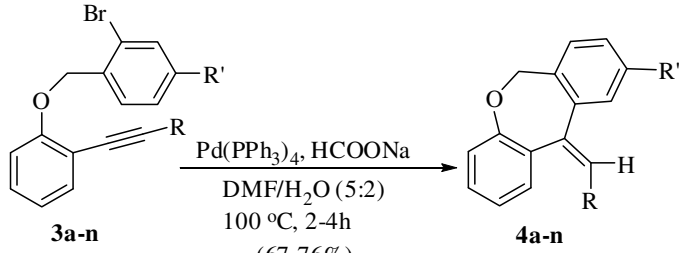
Next we have optimized the reaction conditions using compound **3a** as model substrate for the reductive Mizoroki-Heck reaction. The reaction was performed under conventional conditions by heating in DMF at 120 °C using $Pd(OAc)_2$ as catalyst. The reaction failed in the absence of water probably due to the ineffectiveness of the reducing agent in organic solvent (entry 1). When the reaction was conducted in 1:1 aqueous solution of DMF using the catalysts $Pd(OAc)_2$ and $Pd(PPh_3)_2Cl_2$, the starting material was recovered intact (entries 2, 3). In 1:1 aqueous solution of DMF, tetrakis(triphenylphosphine)palladium(0) (10 mol%) as a catalyst and sodium formate as a reducing agent was effective enough to furnish the desired product in low yield (30%, entry 4). After careful screening we were able to establish the optimal condition as follows: DMF/water (5:2) mixture, $Pd(PPh_3)_4$, HCOONa, at 100 ^oC for 2h (entry 5). We also observed that temperature plays an important role in the cyclization process. As the temperature was increased from 100 ^oC, extensive decomposition of the starting materials occurred leading to lower yields of the cyclized products (entry 6). On the other hand, decreasing the temperature from the optimal temperature results in the recovery of the starting materials. The cyclization process is extremely time dependent. The reaction was run for about 2h. The decrease in the reaction time resulted in the lowering of the product (60%, entry 7). Under the optimized reaction condition the alkyne **3a** was regioselectively cyclized to afford 7-*exo* product **4a** in 76% yield along with the unreacted starting material. Aqueous solutions containing acetonitrile, DME, CH_3CN, THF, gave low yields of the cyclized product (entries 8-10) (Table 1).

Table 1: Optimization of the reductive Mizoroki-Heck reaction[a]

Entry	Catalyst	Solvent (v/v)	Time (h)	Temp. (^0C)	Yield[b] (%)
1	$Pd(OAc)_2$	DMF	2.0	120	---
2	$Pd(OAc)_2$	DMF/H_2O (1:1)	2.0	100	---
3	$Pd(PPh_3)_2Cl_2$	DMF/H_2O (1:1)	2.0	100	---
4	$Pd(PPh_3)_4$	DMF/H_2O (1:1)	2.0	120	30
5[c]	**$Pd(PPh_3)_4$**	**DMF/H_2O (5:2)**	**2.0**	**100**	**76**
6	$Pd(PPh_3)_4$	DMF/H_2O (5:2)	2.0	140	DP[d]
7	$Pd(PPh_3)_4$	DMF/H_2O (5:2)	1.5	100	60
8	$Pd(PPh_3)_4$	DME/H_2O (5:2)	2.0	100	30
9	$Pd(PPh_3)_4$	CH_3CN/H_2O (5:2)	2.0	100	15
10	$Pd(PPh_3)_4$	THF/H_2O (5:2)	2.0	100	15

[a]In all cases HCOONa was used as reducing agent. [b]Isolated yield.
[c]Optimized reaction condition. [d]DP = Decomposed product.

A number of other substrates (**3b-n**) were allowed to react under the aforementioned condition to examine the scope of the reductive Mizoroki-Heck cyclization process (Scheme 2).



3a-n

3a, R = C_3H_7, R' = H
3b, R = C_4H_9, R' = H
3c, R = C_5H_{11}, R' = H
3d, R = C_6H_{13}, R' = H
3e, R = Ph, R' = H
3f, R = $CMe_2(OH)$, R' = H
3g, R = CHMe(OH), R' = H
3h, R = CH_2OH, R' = H
3i, R = $SiMe_3$, R' = H
3j, R = *p*-MeC_6H_4, R' = H
3k, R = *m*-$OMeC_6H_4$, R' = H
3l, R = *p*-$CMe_3C_6H_4$, R' = H
3m, R = C_4H_9, R' = OMe
3n, R = C_5H_{11}, R' = OMe

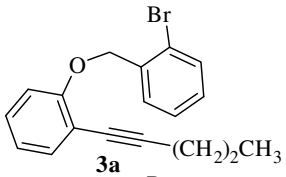
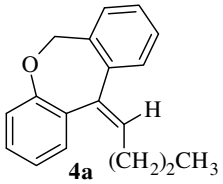
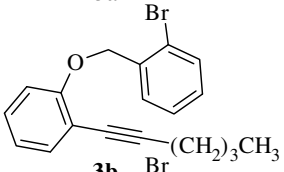
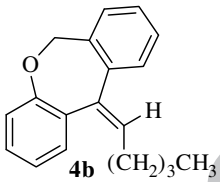
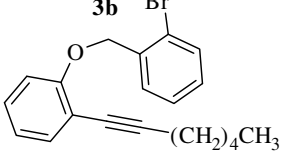
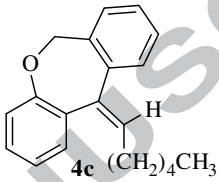
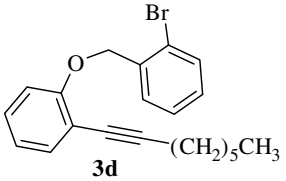
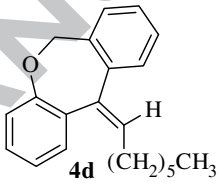
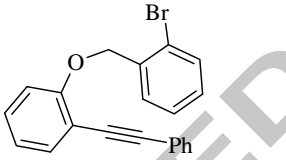
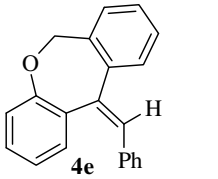
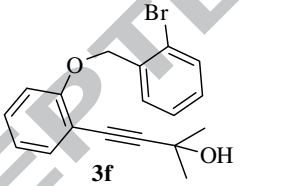
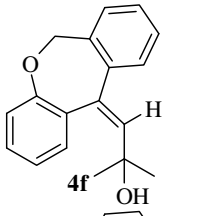
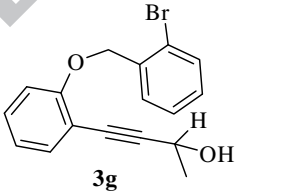
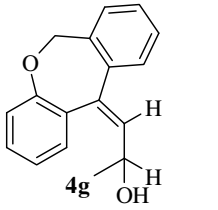
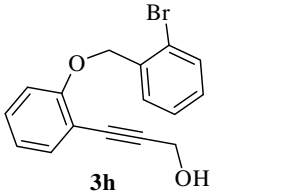
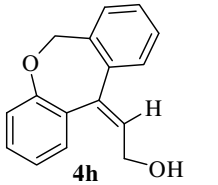
4a-n

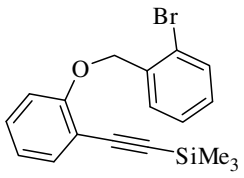
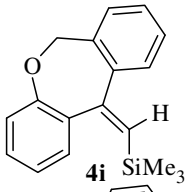
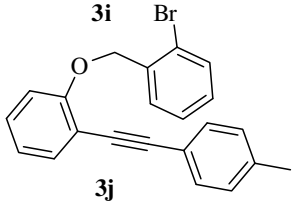
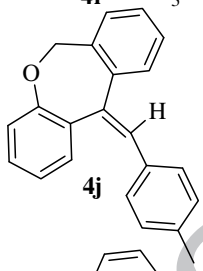
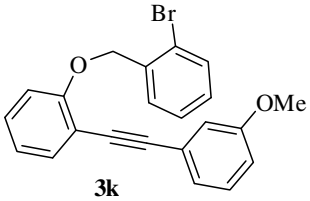
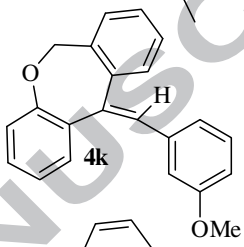
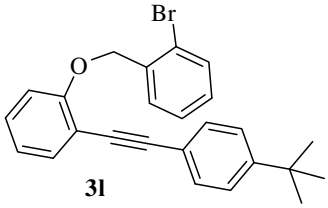
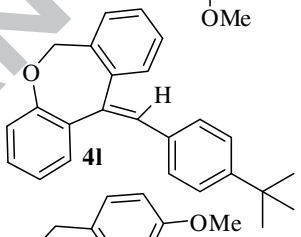
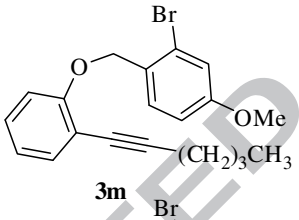
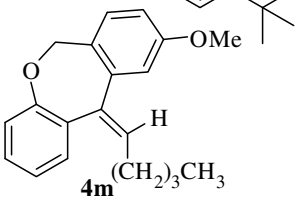
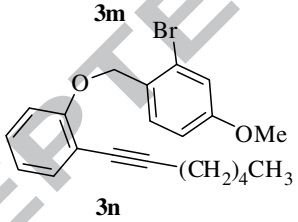
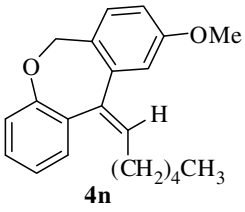
4a, R = C_3H_7, R' = H
4b, R = C_4H_9, R' = H
4c, R = C_5H_{11}, R' = H
4d, R = C_6H_{13}, R' = H
4e, R = Ph, R' = H
4f, R = $CMe_2(OH)$, R' = H
4g, R = CHMe(OH), R' = H
4h, R = CH_2OH, R' = H
4i, R = $SiMe_3$, R' = H
4j, R = *p*-MeC_6H_4, R' = H
4k, R = *m*-$OMeC_6H_4$, R' = H
4l, R = *p*-$CMe_3C_6H_4$, R' = H
4m, R = C_4H_9, R' = OMe
4n, R = C_5H_{11}, R' = OMe

Scheme 2: Reductive Mizoroki-Heck reaction of compounds **3a-n**

Both aliphatic and aromatic alkynes were used in the immediate starting materials **3a-n**. The substrates having aliphatic alkyne part provide higher yields of the cyclized products (68-76%) and for aromatic alkynes the yield is lower (67-69%). The substrates with *p*-methoxy substitution at the phenyl ring of benzyl bromide part (**3m**, **3n**) also furnished higher yields of cyclized products (74%). The results are summarized in Table 2.

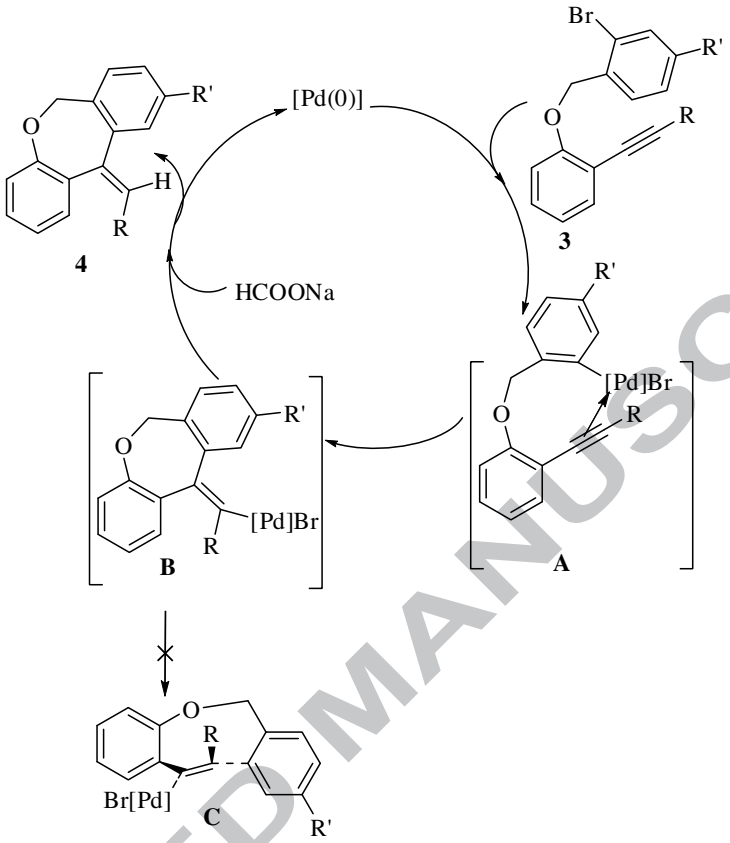
Table 2: Summarized results of the reductive Mizoroki-Heck reaction

Entry	Substrate	Time (h)	Product	Yield(%)
1	 **3a**	2.0	 **4a**	76
2	 **3b**	2.0	 **4b**	76
3	 **3c**	2.0	 **4c**	76
4	 **3d**	2.5	 **4d**	74
5	 **3e**	3.0	 **4e**	67
6	 **3f**	3.5	 **4f**	74
7	 **3g**	3.5	 **4g**	72
8	 **3h**	4.0	 **4h**	68

9	 **3i**	3.5	 **4i**	68
10	 **3j**	3.0	 **4j**	69
11	 **3k**	2.5	 **4k**	67
12	 **3l**	3.0	 **4l**	67
13	 **3m**	2.5	 **4m**	74
14	 **3n**	2.5	 **4n**	74

The regioselective formation of 7-*exo*-cyclized product during the course of the reaction can be rationalized by a mechanism similar to the one proposed in previous reports.[20] An aryl palladium π-complex **A** generated initially from **3**[21] and transformed readily into a σ-vinyl palladium complex **B** *via* simultaneous *syn*-addition to the triple bond. *Endo*-cyclization *via* a hypothetical intermediate **C** is unfavorable due to high strain exerted by the *trans*-geometry around the double bond in the eight-membered intermediate. The σ-vinyl complex readily gets reduced to regenerate the Pd(0) catalyst by means of the reducing agent HCOONa present in the reaction. *Syn*-addition of palladium to the triple bond during the Mizoroki-Heck

reaction implies exclusive formation of dibenzoxepine compounds **4**[22] possessing *Z* configuration of the *exo*-cyclic double bond (Scheme **3**).



Scheme 3: Plausible mechanism of the reaction

Liu *et al*. have developed[23] a general ligand-free palladium catalyzed reductive Heck reaction that was applied to the synthesis of a variety of five- and six-membered oxygen heterocycles in 70–74% yields. In our previous attempt during the synthesis of oxepine derivatives we were only able to manage a mixture of both 7-*exo* and 8-*endo* products under normal Heck reaction condition. Our results on the reductive Heck cyclization in the synthesis of dibenzooxepine derivatives seem to be significant in view of the aforesaid limited literature reports on oxygen containing heterocycles.

In summary, we have developed an efficient and straightforward method for the construction of potentially bioactive dibenzoxepine framework *via* palladium-mediated reductive Mizoroki-Heck cyclization. In this method the 7-*exo*-cyclization products have been obtained regioselectively. The protocol is equally effective for both aliphatic and aromatic alkyne containing substrates.

Acknowledgement:

We thank DST (New Delhi) for financial assistance. We are also thankful to UGC and CSIR (K. C. M. to UGC, New Delhi for a UGC-Emeritus fellowship and T. G. and S. P. to CSIR, New Delhi for their senior research fellowships). We thank DST (New Delhi) for providing Bruker NMR (400 MHz), Perkin-Elmer CHN Analyser, FTIR and UV-Vis spectrometer.

References:

1. (a) Faulkner, D. J. *Nat. Prod. Rep.* **1984**, *1*, 251. (b) Bruder, M.; Haseler, P. L.; Muscarella, M.; Lewis, W.; Moody, C. J. *J. Org. Chem.* **2010**, *75*, 353. (c) Yoshida, M.; Nakatani, K.; Shishido, K. *Tetrahedron* **2009**, *65*, 5702.
2. (a) Oishi, T.; Ohtsuka, Y. *Stud. Nat. Prod. Chem.*; Rahman, A., Ed.; Elsevier: Amsterdam, **1989**, 73. (b) Moody, C. J. *Stud. Nat. Prod. Chem.*; Rahman, A., Ed.; Elsevier: Amsterdam, 1989.
3. (a) Tojo, E.; Dominguez, D.; Castedo, L. *Phytochemistry* **1991**, *30*, 1005. (b) Stefinovic, M.; Snieckus, V. *J. Org. Chem.* **1998**, *63*, 2808. (c) Yamaguchi, S.; Furihata, K.; Miyazawa, M.; Yokoyama, H.; Hirai, Y. *Tetrahedron Lett.* **2000**, *41*, 4787. (di) Yamaguchi, S.; Tsuchida, N.; Miyazawa, M.; Hirai, Y. *J. Org. Chem.* **2005**, *70*, 7505. (e) Sabui, S. K.; Venkateswaran, R. V. *Tetrahedron Lett.* **2004**, *45*, 983. (f) Engler, M.; Anke, T.; Sterner, O. *J. Antibiot.* **1997**, *50*, 330.
4. (a) Tretter, J. R. US Patent 3514449, **1970**; *Chem. Abstr.* **1970**, *73*, 35404u. (b) *Dictionary of Drugs*, 1st ed.; Elks, J.; Ganellin, C. R., Eds.; Chapman and Hall: London, **1990**, 984.
5. (a) Pettit, G. R.; Numata, A.; Iwamoto, C.; Usami, Y.; Yamada, T.; Ohishi, H.; Cragg, G. M. *J. Nat. Prod*. **2006**, *69*, 323–327. (b) Anjaneyula, A. S. R.; Reddy, A. V. R.; Reddy, D. S. K.; Cameron, T. S.; Roe, S. P. *Tetrahedron* **1986**, *42*, 2417–2420.
6. Kittakoop, P.; Nopichai, S.; Thongon, N.; Charoenchai, P.; Thebtaranonth, Y. *Helv. Chim. Acta* **2004**, *87*, 175–179.
7. (a) Zimmermann, K.; Waldmeier, P. C.; Tatton, W. G. *Pure Appl. Chem*. **1999**, *71*, 2039–2046. (b) Zimmermann, K.; Roggo, S.; Kragten, E.; F€urst, P.; Waldmeier, P. *Bioorg. Med. Chem. Lett*. **1998**, *8*, 1195–1200. (c) Sagot, Y.; Toni, N.; Perrelet, D.; Lurot, S.; King, B; Rixner, H.; Mattenberger, L.; Waldmeier, P. C.; Kato, A. C. Br. *J. Pharmacol*. **2000**, *131*, 721–728.
8. Asakawa, Y.; Takikawa, K.; Toyota, M.; Takemoto, T. *Phytochemistry* **1982**, *21*, 2481.
9. Asakawa, Y.; Kusube, E.; Takemoto, T.; Suire, C. *Phytochemistry* **1978**, *17*, 2005.

10. (a) Breuer, M.; Leeder, G.; Proksch, P.; Budzikiewicz, H. *Phytochemistry* **1986**, *25*, 495; (b) McCormic, S.; Robson, K.; Bohm, B. *Phytochemistry* **1986**, *25*, 1723; (c) Asakawa, Y.; Hashimoto, T.; Takikawa, K.; Tori, M.; Ogawa, S. *Phytochemistry* **1991**, *30*, 235; (d) Asakawa, Y.; Kondo, K.; Tori, M. *Phytochemistry* **1991**, *30*, 325.

11. Asakawa, Y. *Pure Appl. Chem*. **2007**, *79*, 557.

12. (a) Engler, M.; Anke, T.; Sterner, O.; Brandt, U. *J. Antibiot.* **1997**, *50*, 325. (b) Wijnberg, J. B. P. A.; van Veldhuizen, A.; Swart, H. J.; Frankland, J. C.; Field, J. A. *Tetrahedron Lett.* **1999**, *40*, 5767.

13. Jung, J. -K; Choi, N. –S.; Suh, Y. –G., *Arch. Pharm. Res.* **2004**, *27,* 985-989.

14. (a) Deiters, A.; Martin, S. F. *Chem. Rev.* **2004**, *104*, 2199. (b) Chattopadhyay, S. K.; Karmakar, S.; Biswas, T.; Majumdar, K. C.; Rahaman, H.; Roy, B. *Tetrahedron* **2007**, *63*, 3919. (c) Villar, H.; Frings, M.; Bolm, C. *Chem. Soc. Rev.* **2007**, *36*, 55. (d) Clark, J. S.; Grainger, D. M.; Ehkirch, A. A.-C.; Blake, A. J.; Wilson, C. *Org. Lett.* **2007**, *9*, 1033.

15. (a) Yet, L. *Chem. Rev.* **2000**, *100*, 2963. (b) Rosillo, M.; Domínguez, G.; Casarrubios, L.; Pérez-Castells, J. *J. Org. Chem.* **2005**, *70*, 10611. (c) Trost, B. M. In *Homogeneous Transition Metal Catalyzed Reactions*; Moser, W. R.; Slocum, D. W., Eds.; American Chemical Society: Washington DC, **1992**, Chap. 31, 463. (d) Coulter, M. M.; Dornan, P. K.; Dong, V. M. *J. Am. Chem. Soc.* **2009**, *131*, 6932.

16. (a) Majumdar, K. C.; Debnath, P. *Tetrahedron* **2008**, *64*, 9799. (b) Majumdar, K. C.; Mondal, S.; Ghosh, D. *Tetrahedron Lett.* **2010**, *51*, 348.

17. (a) Majumdar, K. C.; Sinha, B.; Ansary, I.; Chakravorty, S. *Synlett* **2010**, No. 9, 1407–1411. (b) Majumdar, K. C.; Ansary, I.; Sinha, B.; Roy, B.; Sridhar, B. *Synthesis* **2011**, *20*, 3287-3296.

18. Majumdar, K. C.; Ansary, I.; Sinha, B.; Chattopadhyay, B. *Synthesis* **2009**, *21*, 3596-3602.

19. (a) Tobrman, T.; Dvořák, D. *Tetrahedron Lett.* **2004**, *45*, 273-276. (b) Gao, P.; Cook, S. P. *Org. Lett*. **2012**, *14*, 3340-3343. (c) Donets, P. A.; Eycken, E. V. V. *QSAR Comb. Sci*. **2007**, *26* (11-12), 1239**-**1242. (d) Kim, H. S.; Lee, H. S.; Kim, S. H.; Kim, J. N. *Tetrahedron Lett.* **2009**, *50*, 3154-3157.

20. (a) Donets, P. A.; Eycken, E. V. V. *Org. Lett.* **2007**, *9*, 3017-3020. (b) Majumdar, K. C.; Chakravorty, S.; Ghosh, T.; Sridhar, B. *Synlett* **2009**, 3127-3130.

21. **General procedure for the preparation of staring materials 3a-n:**

A mixture of compound **2** (300 mg, 0.77 mmol), 1-pentyne (68 mg, 1.01 mmol), dry Et_3N (2 ml), $Pd(PPh_3)_2Cl_2$ (27 mg, 5 mol%), and CuI (7 mg, 5 mol%) in dry DMF (5 ml) was

stirred at room temperature for 4 h. After completion of the reaction as monitored by TLC, the reaction mixture was cooled and water (5 mL) was added. This was then extracted with $CHCl_3$ (3 x 15 mL). The $CHCl_3$ extract was washed with water (2 x 10 mL) followed by brine (10 mL). The organic layer was dried (Na_2SO_4). Evaporation of $CHCl_3$ furnished a crude mass which was subsequently purified by column chromatography using silica gel. Elution of the column with petroleum ether afforded the product **3a**. Similarly other alkynes were treated with compound **2** to give the corresponding substrates **3b-n**.

Compound 3a: Yellow gummy, yield = 92%, IR (KBr): 2988, 2933, 2230, 1599 cm^{-1}, ^1H NMR (400 MHz, $CDCl_3$): δ_H = 7.74 (d, 1H, *J* = 7.6 Hz), 7.50 (d, 1H, *J* = 8.0 Hz), 7.40 (d, 1H, *J* = 7.2 Hz), 7.32 (t, 1H, *J* = 7.6 Hz), 7.14-7.24 (m, 2H), 6.90 (t, 2H, *J* = 7.6 Hz), 5.18 (s, 2H), 2.46 (t, 2H, *J* = 6.8 Hz), 1.63-1.70 (m, 2H), 1.05 (t, 3H, *J* = 6.8 Hz). ^{13}C NMR (100 MHz, $CDCl_3$): δ_C = 158.8, 136.5, 133.5, 132.3, 128.9, 128.8, 128.5, 127.5, 121.6, 121.1, 114.1, 112.7, 94.8, 69.7, 22.3, 21.8, 13.6. HRMS (ESI^+): Calcd. for $C_{18}H_{17}BrO$: $[M+H^+]$ 329.0536; found 329.0560.

22. **General procedure for the reductive Mizoroki-Heck cyclization of compounds 4a-n:**

A mixture of the compound **3a** (100 mg, 0.32 mmol), HCOONa (32.9 mg, 0.48 mmol), $Pd(PPh_3)_4$ (11 mg, 9.6 $x10^{-3}$ mmol) in DMF/H_2O (7 mL, 5:2) was heated under continuous stirring at 100 ^oC for 2h. After completion of the reaction as monitored by TLC, the reaction mixture was cooled and water (5 mL) was added. This was then extracted with $CHCl_3$ (3 x 15 mL). The $CHCl_3$ extract was washed with water (2 x 10 mL) followed by brine (10 mL). The organic layer was dried (Na_2SO_4). Evaporation of $CHCl_3$ furnished a crude mass. This was purified by column chromatography over silica-gel. Elution of the column with petroleum ether afforded the product **4a**. Other substrates **3b-n** were similarly treated to give the corresponding products **4b-n**.

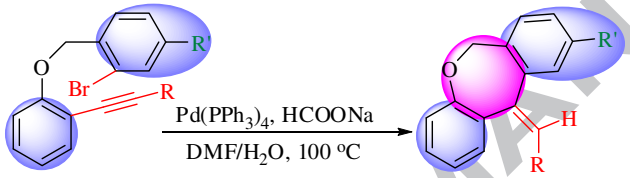
Compound 4a: Gummy, yield = 76%, IR (KBr): 2929, 1602 cm^{-1}, ^1H NMR (400 MHz, $CDCl_3$): δ_H = 7.44 (t, 2H, *J* = 8.0 Hz), 7.34-7.39 (m, 2H), 7.12-7.21 (m, 2H), 6.86-6.96 (m, 2H), 5.68-5.73 (m, 1H), 5.10 (s, 2H), 2.29-2.29 (m, 2H), 1.43-1.53 (m, 2H), 0.95 (t, 3H, *J* = 8.0 Hz). ^{13}C NMR (100 MHz, $CDCl_3$): δ_C = 155.5, 146.2, 139.0, 133.8, 133.4, 131.6, 129.1, 128.5, 127.5, 127.4, 127.2, 126.3, 120.3, 119.5, 70.4, 31.7, 23.3, 14.0. MS (EI): m/z = 251 $[M+H]^+$. Anal. Calcd. for $C_{18}H_{18}O$: C, 86.36; H, 7.25%. Found: C, 86.39; H, 7.22%.

23. Liu, P.; Huang, L.; Lu, Y.; Dilmeghani, M.; Baum, J.; Xiang, T.; Adams, J.; Tasker, A.; Larsen, R.; Faul, M. M. *Tetrahedron Lett.* **2007**, *48*, 2307-2310.

Graphical abstract

A reductive Mizoroki-Heck approach to the dibenzo[b,e]oxepine

K. C. Majumdar,* Tapas Ghosh, Sudipta Ponra
Department of Chemistry, University of Kalyani, Kalyani-741235, W.B., India



R = C_3H_7, C_4H_9, C_5H_{11}, C_6H_{13}, Ph, $CMe_2(OH)$, $CHMe(OH)$, CH_2OH, $SiMe_3$, *p*-MeC_6H_4, *m*-$OMeC_6H_4$, *p*-$CMe_3C_6H_4$

R' = H, OMe

E-mail: kcm@klyuniv.ac.in