PROFESSOR TUTICORIN RAGHAVACHARI GOVINDACHARI
A TRIBUTE

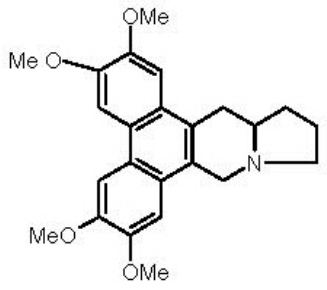
Prof. T.R. Govindachari (well-known in professional circles as TRG) completed 85 years of age in July 2000. I met him for the first time in 1949 as a student of B.Sc. Honors in Chemistry at Loyola College, Madras (now called Channai, Tamilnadu). He had just returned from U.S.A and joined the Chemistry Department of Presidency College and was offering lectures in mechanistic organic chemistry at an inter-collegiate level. My association has continued since then in various capacities – as Ph.D. student (his first), post-doctor, Head of Medicinal Chemistry when he was Director of Ciba Research Center, Bombay and later as fellow organic chemist and admirer. I feel highly privileged to contribute this article to an issue dedicated to TRG, drawing upon my memory and a couple of appreciations I had written earlier on him.[1,2]

TRG was born in Madras on July 30, 1915. In 1932, he joined the Presidency College, Madras, an institution with which he would be associated for the next thirty years in different capacities. After passing B.Sc. in first class, he worked under Prof. B.B. Dey as a research student on isoquinolines[3]. Having qualified for the M.Sc degree, he continued with Prof. Dey as an assistant under a C.S.I.R scheme on the production of dye and drug intermediates by electrolytic processes (a war time effort)[4]. Based on this work and his earlier studies on isoquinolines, he was awarded the Ph.D. degree by the MadrasUniversity.

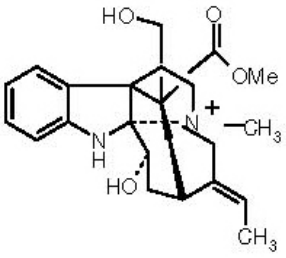
TRG went to the United States as a Government of Madras scholar in 1946. He spent three years as a post-doctoral fellow with Prof. Roger Adams at the University of Illinois, Urbana, Illinois, investigating the Senecio alkaloids[5]. He also contributed two important chapters on isoquinolines for the series, Organic Reactions edited by Prof. Roger Adams[6]. TRG left an indelible impression in this circle by virtue of his systematic, painstaking and insightful scientific

approach.

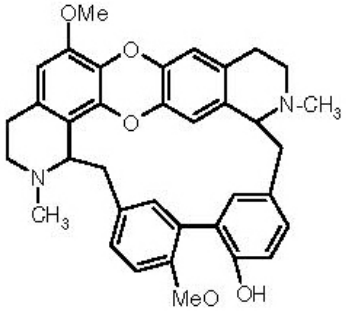
TRG returned to India in 1949 and joined his alma mater as Additional Professor of Chemistry in January 1950. He became Chief Professor in 1952 and Principal of the college in 1961. During these years, he built up painstakingly an active group of research scholars and carried out pioneering work in natural products chemistry, concentrating particularly on Indian medicinal plants. The work resulted in 25 students getting the Ph.D. degree. Many of them became well known in their own right in subsequent years. His researches during this period led to the isolation and structural elucidation of several novel types of alkaloids, terpenes and oxygen heterocycles, e.g tylophorine **1**[7],carpaine[8], echitamine **2,**[9] tiliacorine **3,**[10] kopsine **4** [11](with Prof. H. Schmid)), cedrelone **5** [12](with Prof.D.Arigoni), polyalthic acid **6**,[13]and wedelolactone **7**[14] and of the biogenetically important alkaloids, reticuline **8**[15] and gentianine **9**[16]. The results which were achieved inspite of scanty resources (a manually operated Beckman model DU Spectrophotometer was the sole instrument available for many years!) were published in various international and national peer-reviewed journals and served to establish his reputation as a natural products chemist and that of Presidency College, Madras as a premier center of international caliber. He also came to be recognized as a persuasive teacher of modern organic chemistry. During these eventful years, his colleague, Prof. B.R.Pai was a pillar of support to him in many ways, especially with his dexterity in untangling bureaucratic webs and mobilizing research funds.



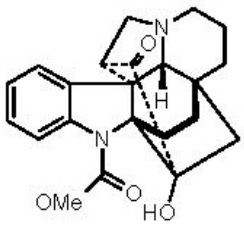
1



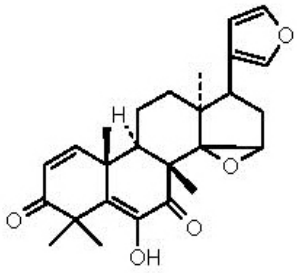
2



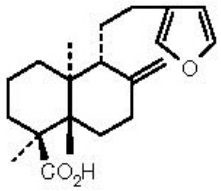
3



4



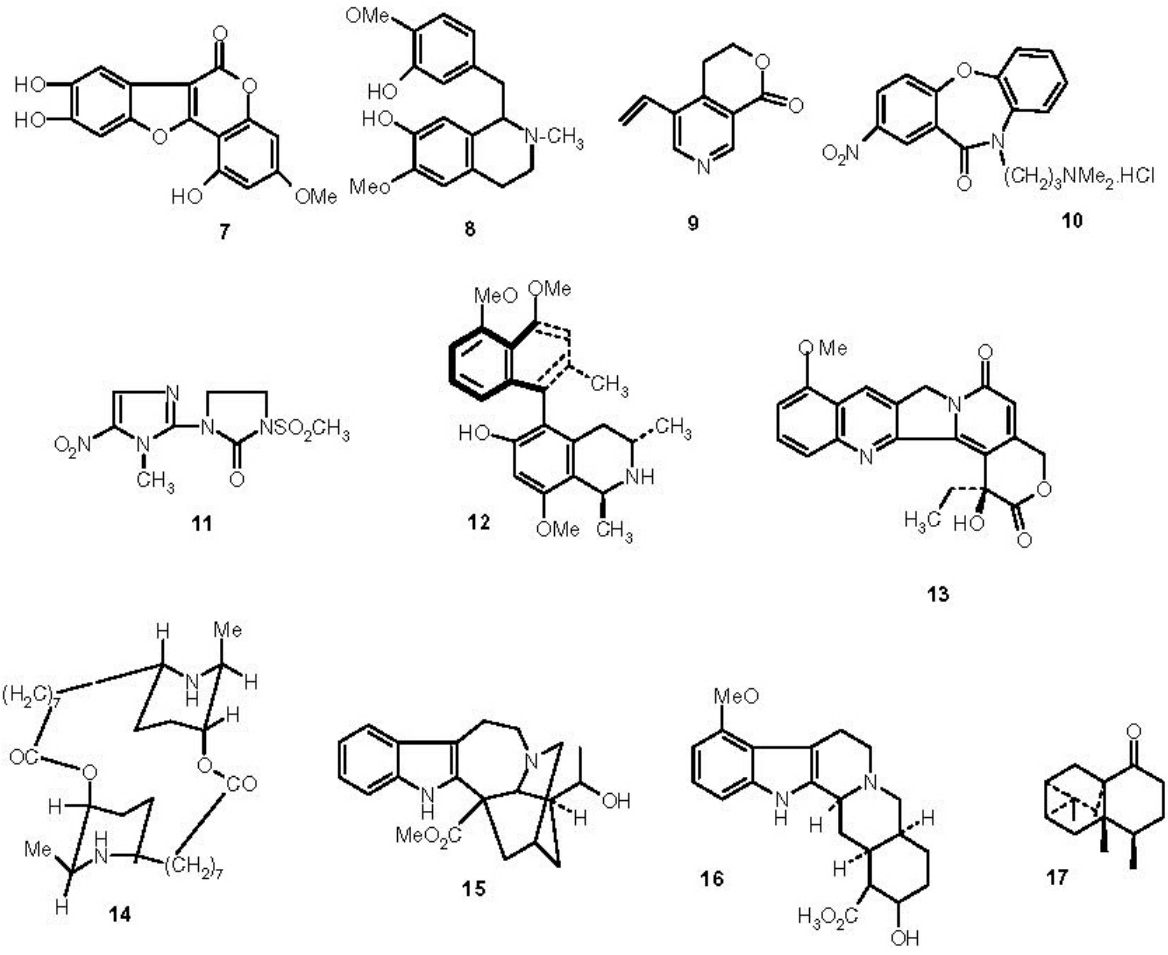
5



6

In 1963, TRG was invited to become the first Director of the newly established CIBA Research

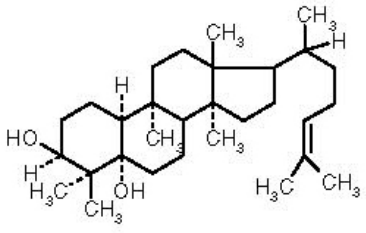
Center in Bombay. The Center had as one of its goals, the discovery and development of synthetic and natural products for the treatment of diseases, particularly those endemic to the tropical countries. The synthesis of dyestuffs for application to artificial fibers was another important objective of that Center. As Director, TRG was responsible for assembling a team of highly talented and trained chemists and biologists and guiding their efforts into fruitful channels. During his stewardship, the Centre had screened more than 10000 new compounds and plant extracts out of which twenty were taken to the clinic and marketing approvals obtained for five drugs, one of them being sintamil **10.**[17] A second one, satranidazole **11**[18] has been also recently introduced into the Indian market. The Center also earned international reputation for basic research in chemical and biological sciences, which together with its beautiful campus made it a mandatory destination for scientific visitors to the country.



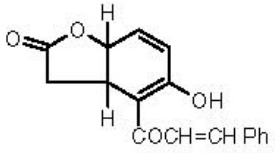
Management of an institution of this kind entailed heavy responsibility and placed a premium on the Director's time. Nevertheless, TRG could find time to pursue his special interest in natural products chemistry and published extensively on alkaloids like the novel polyketide naphthylisoquinoline, ancistrocladine **12**[19], methoxycamptothecin **13**[20], carpaine, pseudocarpaine **14**[21], heyneanine **15**[22], atalaphylline[23] and venenatine **16**[24], terpenes like veprisone[25], ishwarone

17[26], litsomentol **18**[27] and wightinolide[28] and oxygen heterocycles like wightine[29], echiodine[30], surangin A and B[31] and cryptocaryone **19**[32]. He also wrote many review articles for well-known monographs and journals[33-39]. Special mention must be made here of the systematic investigations made by him and members of the natural products group at CIBA of a very large number of Indian plants which were subjected to broad biological screening[40]. The period 1955 to 1975 can be considered as the Golden Era of Natural Products Chemistry in India and TRG made a significant contribution to it.

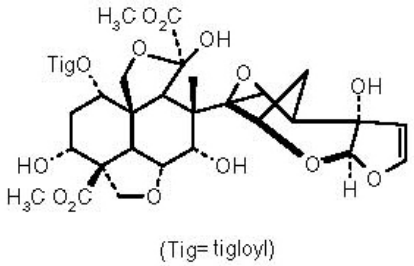
After his retirement from CIBA-Geigy Research Center , Bombay in July 1975, TRG was invited to be a consultant for Central Leather Research Institute in Madras for two years. Then he took up the major task of establishing a decent R&D facility for Madras based Pharmaceutical company, Amrutanjan (1977-1986). He collected a good team of scientists and pursued his work on natural products[41,42] in addition to process development of drugs. Apart from the elaboration of a viable process for the extraction and purification of the Vinca alkaloids, TRG initiated a major sustained program for the study of the constituents of the neem tree (Azadirachta indica). Earlier in his group, around 1957, his associate, N.S. Narasimhan in Presidency College, had carried out some of this work. But in the ensuing years, the importance of the plant had assumed explosive proportions because of the isolation of the well-known antifeedant, azadirachtin A and its structural elucidation. The work taken up by TRG at Amrutanjan was carried over to the Centre for Agrochemical Research which he set up for Southern Petrochemical Industrial Corporation, a fertilizer giant, again in Madras and which he has been guiding until very recently(1987 -2001). At this Centre, which is modest in size but very well equipped and staffed by enthusiastic and experienced organic chemists and entomologists, TRG has carried out very significant work on the constituents of neem. His passion bordering on obsession has resulted in the isolation and structure assignment of several members of the azadirachtin family[43,44]. More importantly he has been successful in isolating crystals of pure azadirachtin A **20**[45] and getting a single crystal X-ray structure done[46]. Additionally TRG's group at SPIC has been involved in a systematic bioactivity- assisted study of many other Indian plants[47,48].



18



19



20

TRG's research career, spanning a period of more than six decades, has been extraordinarily fruitful as evidenced by his publications numbering around 330 in the field of alkaloids,

terpenoids, oxygen heterocycles and other classes of natural products as well as in the synthesis of heterocycles like isoquinolines[49], phenanthridines[50], benzophenanthridines[51], pyridophenanthrenes (aporphines)[52] and dibenzoquinolizines (protoberberines)[53], often related to the structures he had elucidated and occasionally covering total synthesis. Among natural product chemists, he may be one among a small number who has handled a bewildering variety of structures without inviting the criticism of spreading himself too thin. National recognitions for his achievements came to him in the form of many awards: Shanti Swarup Bhatnagar Award for Chemical Sciences, 1960; Prof. K. Venkataraman Endowment Lectureship of Bombay University for 1965-1966; Sir S.Subramania Iyer Lectureship in Physical Sciences of the Madras University for 1969-1970; Dr. Mahendralal Sircar Memorial Lectureship for 1970; H.K.Sen Memorial Lectureship for 1970; Indian National Science Academy's awards, Megnad Saha Medal for 1975, Golden Jubileee Commemoration Medal and Life Time Achievement Award of Chemical Research Society of India for 2000. He was the President of the Indian Chemical Society for 1971-1972. International recognition of his contributions came in 1960 when he was invited to give a plenary lecture in the first ever meeting of the Natural Products Section of the International Union of Pure and Applied Chemistry (IUPAC). Later in1963 he was elected a member of IUPAC for 8 years. He has been a delegate of the Indian team in the Indo-Soviet Conference on Natural products held alternately in Russia and India. He has been an invited speaker in many international conferences on natural products, especially in recent years in symposia on neem.

TRG is a Fellow of the Indian National Science Academy and the Indian Academy of Sciences. He has been a member of many scientific societies like the Chemical Society, London (now the Royal Society of Chemistry), the American Chemical Society and the Swiss Chemical Society. He is a Founder Trustee of the National Organic symposium Trust, a non-profit organization in India for the promotion of Organic Chemistry.

In addition to his scientific pursuits, TRG has utilized his skills in science management and administration for the benefit of the country in several ways. He has been associated with the Research Councils of institutions like National Chemical Laboratory, Pune and Central Drug Research Institute, Lucknow. He served as a member of the Pharmaceuticals and Drugs Committee of the Council of Scientific and Industrial Research of the Government of India for several years. He is a founder member of the editorial board of the Indian Journal of Chemistry. He has been connected with several Universities, whose boards of studies have utilized his knowledge for improving the curricula and teaching systems.

While natural products chemistry is TRG's foremost passion, his partiality for horticulture is not far behind. He has created for himself a reputation for cultivation of roses and orchids. Bombay's climate is well suited for roses and thanks to TRG, the CIBA Research Centre's campus (including the Director's bungalow) was famous for those flowers. Madras on the other hand has

climatic conditions more suited for the cultivation of orchids. TRG would not lose such an opportunity and has created a lovely orchid garden in his home. The enthusiasm that TRG displays while showing his collection to the visitors is rivaled only by the riotous splendor of a hundred orchid hues! In pursuit of his deep interest in natural products chemistry, he would often go on plant collection trips along with his favorite students or coworkers. Occasionally this would end in visits to nearby temples, well or little known, whose architecture and sculptures had an unceasing fascination for him. TRG is also fond of classical music and dance as well as of literature.

On the home front, TRG had a long and happy married life with Mrs. Rajamani until her death some years ago. They have three children, two sons and a daughter. The elder son, Dr.T.G. Rajagopalan retired as Director, R&D of Proctor & Gamble at their Centre in India. The younger son, T.G. Sundararajan was Director, Finance with Air India. The daughter, Mrs. Anuradha Jagannathan, married to an engineer, is an accomplished Bharathanatyam (classical South Indian) dancer. TRG has grand children through all the three, who are mostly located in USA. Reluctant breaks from his scientific routine will see TRG spending a short vacation with the grand children.

TRG is mild in appearance and speech and is easily accessible. A brief encounter with him leaves a deep impression of his erudition on the visitor. Shy by nature and reticent by disposition, he is modest to a fault. At the same time, he is friendly and very helpful to his students, associates and acquaintances. He would remark once in a while that he was not a ‘committee man’ but he did stoutly support and defend persons, principles and projects he had committed himself to. The field of organic chemistry, especially of natural products, has been enriched considerably by TRG’s endeavors over the decades and the scientific community, particularly in India has benefited from them. I for one have been extremely fortunate to have had him as my guide and mentor.

References

1. Nagaarajan, K; Pai, B.R. *J.Sci.Ind. Res*. **1976**, *35*, 139.
2. Nagarajan,K. *Curr.Sci*., **1995**, *69*, 373.
3. Dey,B.B.;Govindachari, T.R. *Arch.Pharm*. **1939**, 177.
4. Dey,B.B.; Govindachari,T.R..;Rajagopalan, S.C. *J.Sci.Ind.Res*. **1947**, *6B*, 103
5. Adams,R; Govindachari, T.R. *J.Am.Chem.Soc.* **1950**, *72*, 158.
6. Whaley, W.M.; Govindachari, T.R**.** *Organic Reactions* John Wiley & Sons: New York 1951; Vol VI.
7. Govindachari,T.R.; Lakshmikantham, M.V.; Nagarajan, K; Pai, B.R. *Chemy. Ind*. **1957**, 1484.

8. Govindachari, T.R.; Narasimhan, N.S. *J. Chem. Soc*. **1955**, 1563.
9. Govindachari, T.R.; Rajappa, S. *Tetrahedron* **1961**, *15*, 132.
10. Anjaneyulu, B.; Gopinath, K.W.; Govindachari, T.R.; Pai, B.R. *Chemy. Ind*. **1959,** 702
11. Govindachari, T.R.; Pai, B.R.; Rajappa, S.; Viswanathan, N.; Kump, W.G.; Nagarajan, K.; Schmid, H. *Helv. Chim. Acta* **1962**, *45*, 1146.
12. Gopinath, K.W.; Govindachari, T.R.;Parthasarathy, P.C.;Viswanathan, N.; Arigoni, D.; Wildman, W.C. *J. Chem. Soc***. 1961**, 446.
13. Gopinath, K.W.; Govindachari, T.R.; Parthasarathy, P.C.; Viswanathan, N. *Helv. chim. Acta* **1961**, *44*, 1040.
14. Govindachari, T.R.; Nagarajan, K.; Parthasarathy, P.C. *J. Chem. Soc*. **1957**, 548.
15. Gopinath, K.W.; Govindachari, T.R.; Viswanathan, N. *Ber.* **1959**, *92*, 1657.
16. Govindachari, T.R. ; Nagarajan, K.; Rajappa, S. *J. Chem. Soc*. **1957**, 1725.
17. Nagarajan, K.; David, J.; Grewal, R.S.; Govindachari, T.R. *Ind. J. Exp. Biol*. **1974**, *12*, 217.
18. Nagarajan,K.; Arya, V.P.; George,T.; Nair, M.D.; Sudarsanam, V.; Ray, D.K.; Srivastava, V.B. *Ind. J. Chem.* **1984,** *23B*, 342.
19. Govindachari, T.R.; Nagarajan, K.; Parthasarathy, P.C.; Rajagopalan, T.G.; Desai, H.K.; Kartha, G.; Chen, S.L.; Nakanishi, K. *J. Chem. Soc.* **1974**, 1413.
20. Govindachari, T.R.; Viswanathan, N. *Ind. J. Chem*. **1972**, *10*, 453.
21. Govindachari, T.R.; Nagarajan, K.; Viswanathan, N. *Tetrahedron Lett*., **1965**, 1907.
22. Govindachari,T.R.; Joshi, B.S,; Ganguly, A.K.; Sathe, S.S.; Viswanathan, N. *Tetrahedron Letters* **1965**, 3873.
23. Govidachari, T.R.; Viswanathan, N.; Pai, B.R.; Ramachandran, V.N.; Subramanian, P.S. *Tetrahedron* **1970**, *26*, 2905.
24. Govindachari, T.R.; Madhavan Pillai, P.; Nagarajan, K.; Viswanathan, N. *Tetrahedron* **1965**, *21*, 2957.
25. Govindachari, T.R.; Joshi, B.S.; Sundararajan, V.N. *Tetrahedron* **1964**, *20*, 2985.
26. Fuhrer, H.; Ganguly, A.K.; Gopinath, K.W.; Govindachari, T.R.; Nagarajan, K.; Pai, B.R.; Parthasarathy. P.C. *Tetrahedron* **1970**, *26*, 2371.
27. Govindachari, T.R.; Viswanathan, N.; Mohamed, P.A. *Chem. Commun*. **1971**, 665.
28. Joshi, B.S.; Kamat, V.N.; Govindachari, T.R.; Pai, B.R.; Kartha, G.; Go, K.T. *J.Che. Soc. Perkin I* **1974**, 2517.
29. Govindachari, T.R.; Parthasarathy, P.C.; Pai, B.R.; Subramanian, P.S. *Tetrahedron* **1965**, *21*, 3237.
30. Govindachari, T.R.; Parthasarathy, P.C.; Pai, B.R.; Subramanian, P.S. *Tetrahedron* **1965**, *21*, 3715.
31. Joshi, B.S.; Kamat, V.N.; Govindachari, T.R.;Ganguly, A.K. *Tetrahedron* **1969**, *25*, 1453.
32. Govindachari, T.R.;Parthasarathy, P.C.; Desai, H.K.; Shanbag, M.N. *Tetrahedron* **1973**, *29*, 3091.
33. Govindachari, T.R.*J. Int. Union Pure Appl. Chem*. **1961**, *2*, 425.
34. Govindachari, T.R. *Proceedigs of the Symposium on Phytochemistry, University of Hong*

Kong, **1961**, 37.
35. Govindachari, T.R. *The Alkaloids Ed. R.H.F. Manske*, Academic Press: New York 1967; 9, 517.
36. Govindachari, T.R.; Parthasarathy, P.C. *Heterocycles* **1977**, *7*, 661.
37. Govindachari, T.R. *Proceedings in Life Sciences* Wagner, H.; Wolff, R., Eds; Springer Verlag: Berlin- Heidelberg, 1977.
38. Govindachari, T.R.; Viswanathan, N. *Heterocycles* **1978**, *11*, 587.
39. Govindachari, T.R. *Heterocycles Special Issue* **1987**, *25*, 659.
40. Desai, H.K.; Gawad, D.H.; Govindachari, T.R.; Joshi, B.S.; Parthasarathy, P.C.; Ramachandran, K.S.; Ravindranath, K.R.;Sidhaye, A.R.; Viswanathan, N. *Ind. J. Chem.* **1976**, *14B*, 473 and earlier papers in this series.
41. Govindachari, T.R.; Premila, M.S. *Phytochemistry* **1983**, *22*, 755.
42. Govindachari, T.R.; Sandhya, G.; Chandrasekaran, S.; Rajagopalan, K. *Chem. Commun*. **1987**, 1137.
43. Govindachari, T.R.; Sandhya, G.; Ganeshraj, S.P. *J. Nat. Prod*. **1992**, *55*, 595.
44. Govindachari, T.R.; Gopalakrishnan, G. *Phytochemistry* **1997**, *45*, 397.
45. Govindachari, T.R.; Gopalakrishnan, G.; Raghunathan, R.R.; Rajan, S.S. *Curr. Sci*. **1994**, *66*, 295.
46. Kabaleeswaran, V.; Rajan, S.S.; Govindachari, T.R.; Gopalakrishnan, G. *Curr. Sci.*. **1994**, *66*, 362.
47. Govindachari, T.R.; Suresh, G.; Banumathy, B.;Masilamani, S.; Gopalakrishnan, G.; Krishnakumari, G.N. *J. Chem. Ecology* **1999**, *25*, 897.
48. Govindachari, T.R.; Suresh, G.; Masilamani, S. *Fitoterapia* **1999**, *70*, 417.
49. Govindachari, T.R.; Pai, B.R.; Ramadas Rao, U. *Proc. Ind. Acad.Sci*. **1958**, *48*, 111.
50. Govindachari, T.R.; Nagarajan, K.; Sundararajan, V.N. *Tetrahedron* **1961**, *15*, 60.
51. Gopinath, K.W.; Govindachari, T.R.; Nagarajan, K.; Purushothaman, K.K. *J. Chem. Soc*. **1958**, 504.
52. Govindachari, T.R.; Nagarajan, K.; Ramdas, C.V. *J. Chem. Soc*. **1958**, 983.
53. Govindachari, T.R.; Nagarajan, K.; Rajeswari, S.; Suguna, H.; Pai, B.R. *Helv. Chim. Acta* **1977**, *60*, 2138.

K.Nagarajan
Hikal R&D Centre
Bannerghatta Road
Bangalore 560076, India
Email n_kuppuswamy@hotmail.com
September20, 2001