

**Comparative Embryology of Angiosperms.** Johri, B. M., Ambegaokar, K. B., Srivastava, P. S. Vols 1-2. Springer-Verlag, Berlin. 1992. pp. 1221. DM 690.

We welcome the appearance of this important publication. It portrays within its massive two volumes of more than 1200 pages and 362 figures the saga of a century's achievements in the field of Angiosperm Embryology. The book is dedicated with their portraits to Professors Karl Schnarf and Panchanan Maheshwari who provided the inspiration and direction to the development of this subject bringing it to the forefront among botanical disciplines. The two volumes give a succinct account of the voluminous literature available on angiosperm embryology estimated at more than 5000 publications originating from laboratories the world over for more than a century. It may be appropriate here to give a brief historical perspective of the subject and the institutions and personnel associated with it which will highlight the significance of the present publication.

Angiosperm embryology has a long history. Towards the close of the nineteenth century, Leon Guignard in Paris published his thesis (1881) on the embryology of the Leguminosae. This was perhaps the first comparative study of the embryology of a large number of species of a single family. At the turn of the century, J. M. Coulter and C. J. Chamberlain of the University of Chicago published their book, *Morphology of angiosperms* (Chicago Univ. Press, 1903) which documented the information then available on the subject. J. H. Schaffner who graduated from the University of Chicago had set up a laboratory at the Ohio State University in Columbus where he published his classic paper on the embryogeny of *Capsella* in 1906. Following the tradition of morphological work done by pioneers like Hoffmeister, Hanstein, Hegelmaier, Guignard, Strasburger, Van Tieghem, S. G. Nawaschin and others in the nineteenth century, several European laboratories embarked on embryological studies in the early decades of the present century. In France, René Souèges at the Faculty of Pharmacy in Paris, in a remarkable career of sustained research over a period of six decades, published numerous monographs and research papers which appe-

ared at regular intervals and were noted for the precise depiction of cell lineage in early embryogenesis. His work was interrupted only by his death at an advanced age in 1967. Pierre Crété, André Lebégue, J. C. Mestré, J. L. Guignard were among the many embryologists associated with Souèges. Important embryological contributions were made by workers in Sweden, particularly at the University of Uppsala. Among them were F. Skottsberg, G. Samuelsson, J. Mauritzon, K. V. O. Dahlgren, A. Håkansson, Helge Stenar, Gunnar Harling, Folke Fagerlind, Karl Afzelius, H. K. Svensson, Johan Wiger and others. Italy had A. Chiarugi, G. Martinoli, Bambacioni-Mezzetti, Emilio Battaglia, F. D'Amato among others. In Russia, W. W. Finn, J. Modilewski in the early years and later P. A. Baranov, Poddubnaja-Arnoldi, M. S. Yakovlev, Gerassimova-Navashchina made important contributions. Baranov also published a book on the subject. In recent years, T. B. Batygina and her associates have been active in this field. In Germany-Austria, P. N. Schüroff, Karl Schnarf, Rosalie Wunderlich, H. D. Wulff, Barbara Haccius and Kurt Steffen are well known for their embryological work. It was Karl Schnarf, however, who made the greatest impact on Angiosperm Embryology. His book, *Vergleichende Embryologie der Angiospermen* (Bornträger, Berlin) published in 1931 is a landmark in the history of angiosperm embryology. This proved to be a rich source of literature on various families published up to that time which was of the greatest use to workers in other parts of the world. Elsewhere in Europe embryological work came from Norway (R. Y. Berg), Denmark (O. Hagerup), Netherlands (F. D. Boesewinkel, F. Bouman, W. A. Van Heel), Poland (H. Babis, R. Czapik, J. Malecka), Switzerland (A. Rutishauser, P. K. Endress), former Yugoslavia (I. M. Glišić) and former Czechoslovakia (O. Erdelská in recent years).

It was in the early 1930s that India entered the scene with Winfield Dudgeon at Allahabad and M. A. Sampathkumaran at Bangalore initiating work in angiosperm embryology. Both of them had received their doctoral degrees at Chicago under C. J. Chamberlain. P. Maheshwari obtained his doctoral degree at Allahabad and moved to Agra where he set up a school specializing in embryology. B. M. Johri

was among his earliest pupils and his doctoral thesis on the embryology of the Alismataceae may be considered the first work in India on the comparative embryology of an angiosperm family. At Bangalore, the Mysore University had instituted the Master's Degree course in Botany for the first time and the first batch of dissertations for this degree in angiosperm embryology was presented in 1933. This reviewer who entered the Central College in Bangalore that year as a student was a witness to this event and since then he has been a keen follower of the progress of this discipline over a period of sixty years leading to the publication of this *magnum opus*, now under review, a Diamond Jubilee offering from India! Elsewhere in the country, embryological laboratories functioned in the early 1930s at Banaras and Calcutta. At Banaras, A. C. Joshi led an active school with his associates, J. Venkateswarlu, L. B. Kajale, C. Venkata Rao, Y. S. Rao and others. They published important comparative accounts of the embryology of Centrospermae, Malvales, Myrtiflorae, Liliales among other orders of angiosperms. I. Banerji at Calcutta investigated the Scrophulariaceae. Venkateswarlu later set up his own laboratory at the Andhra University in Waltair. L. B. Kajale moved to Nagpur which later became an important centre with contributions coming from V. R. Dnyansagar (Mimosaceae), P. K. Deshpande (Asteraceae) and others. From the Agra School, V. Puri went to Meerut, B. Tiagi to Jaipur and Bahadur Singh to Lucknow where they initiated similar studies. Later at Meerut, Y. S. Murty studied the Piperales. At Jaipur B. Tiagi was associated with Dalbir Singh, H. S. Narayana, N. Chandra and others. Reayat Khan, a former pupil of P. Maheshwari worked at Aligarh and from this laboratory came important contributions from Khan, M. Farooq, S. A. Siddiqui particularly on the Lentibulariaceae. H. Maheshwari Devi continued the work at Waltair after J. Venkateswarlu's demise. C. Venkata Rao contributed significantly to the embryology of the Proteaceae at Guntur and B. S. M. Dutt, also from the Andhra School worked on the Amaryllidaceae. Gujarat University in Ahmedabad was another centre where C. K. Shah worked on the Cyperaceae. In the meantime, the Bangalore School at Central College flourished with significant work coming from L. N. Rao (Santalaceae), C. V. K.

## BOOK REVIEWS

Iyengar (Scrophulariaceae), S. B. Kausik (Proteaceae), B. G. L. Swamy (Orchidaceae), K. Subramanyam (Campanulatae), Govindappa Arekal (Gesneriaceae) and others. Arekal later moved to Mysore and in association with D. Raju, S. N. Ramaswamy, C. R. Nagendran and others contributed to the embryology of many families, among them, the Selaginaceae, Burmanniaceae, Xyridaceae, Podostemaceae in particular. In all the above studies, in the early years, Schnarf's classic book had played an important part in providing the necessary literature references. P. Maheshwari visited Schnarf's laboratory in Vienna and other centres in Europe and later the United States, gathering material for his planned textbook on angiosperm embryology. In 1937 Maheshwari reviewed briefly the work done in India up to that time in *Current Science*. He later wrote an authoritative review of the microsporangogenesis and male gametophyte and the female gametophyte in the *Botanical Review* (1948, 1949). He went to Dacca for a few years where he collaborated with Shamsul Islam, A. M. Eunos, A. Haque and others in embryological studies. After the partition of India, Maheshwari moved back to Delhi where B. M. Johri had joined earlier and organized the most productive school for angiosperm embryology which soon attained international recognition. Maheshwari published his well-known book, *An Introduction to the Embryology of Angiosperms* (McGraw-Hill, 1950) which attracted worldwide attention and was also translated to Russian. He established the International Society of Plant Morphologists at Delhi with its journal *Phytomorphology*. Maheshwari built up one of the finest collections of embryological literature in the world and was generous with loan of literature and guidance to workers in other parts of the country (this reviewer was one such beneficiary). At Delhi, Maheshwari was associated with B. M. Johri, S. Narayanaswamy, R. N. Kapil, H. Y. Mohan Ram, Manasi Ram, S. C. Maheshwari, S. C. Gupta, R. N. Chopra, N. N. Bhandari, S. P. Bhatnagar, M. R. Vijayaraghavan, P. R. Mohan Rao and several others and they made many important contributions particularly to the Santalales. Visitors from abroad like Gwenda Davis from Australia, F. Bouman from Netherlands, P. K. Endress from Switzerland and Victor

Garcia from Venezuela worked at this laboratory.

The year 1950 also saw the publication of another important book *Plant Embryology* by D. A. Johansen (Chronica Botanica). This book documented the work done in the world on embryogeny and cited many Indian contributions which by then had been substantial. Elsewhere in the United States, Barbara Palser at Chicago and later at Rutgers, D. C. Cooper in Wisconsin, Richard Popham at Columbus, D. H. Campbell, H. F. Copeland and M. S. Cave in California were among those who made embryological contributions. In the United Kingdom, C. W. Wardlaw published his *Embryogenesis in Plants* (Methuen, 1955) and in later years E. J. H. Corner published his well-known book *The Seeds of Dicotyledons* in two volumes (Cambridge Univ. Press, 1976). J. Heslop-Harrison has contributed significantly to pollen studies. B. G. L. Swamy who had proceeded to Harvard University made important contributions to the embryology of the Magnoliales, particularly the vesselless dicotyledonous families, in association with Prof. Irving W. Bailey. On return to India, he set up a laboratory at the Presidency College in Madras and in association with K. Periasamy, K. K. Lakshmanan, N. Parameswaran, D. Padmanabhan, K. V. Krishnamurthy and others investigated the embryology of many families, particularly the monocotyledonous ones. Swamy also published his book, *From Flower to Fruit* (with K. V. Krishnamurthy, Tata-McGraw Hill, 1980). Embryological work has also been done at other laboratories in the country. Among them may be mentioned, at Pilani (B. N. Mulay, N. C. Nair), Pune (T. S. Mahabale), Dharwar (M. S. Chennaiveerai, P. S. Chikkannaiya) and Warangal (L. L. Narayana), and in earlier years at Annamalainagar (T. S. Raghavan)

Angiosperm embryology which had been mostly descriptive thus far turned to the experimental and systematic phase after the mid-1950s. *Recent Advances in the Embryology of Angiosperms* (1963) edited by P. Maheshwari for the International Society of Plant Morphologists had chapters on experimental embryology (J. P. Nitsch) and embryology and taxonomy (B. M. Johri). Experimental embryology is another story. It has its own identity and

is outside the scope of the present publication. This subject has been adequately covered in two recent books, *Experimental Embryogenesis in Vascular Plants* by V. Raghavan (Academic Press, 1976) and *Experimental Embryology of Vascular Plants* by B. M. Johri (Springer-Verlag, 1982). Experimental Embryology has been developed at the Ohio State University in Columbus and at the University of Delhi among other centres in the world. V. Raghavan who heads the embryology laboratory at Columbus has continued the tradition set up by Schaffner (this reviewer had the privilege of spending a year at the laboratory in 1953-1954). Raghavan has more recently edited a comprehensive work on angiosperm embryology, *Embryogenesis in Angiosperms: A Developmental and Experimental Study* (Cambridge Univ. Press, 1986) and B. M. Johri has likewise published his *Embryology of Angiosperms* (Springer-Verlag, 1984).

The concept of *New Systematics* had come into vogue in the meantime and this introduced the role of anatomical, biochemical, cytological, embryological and other morphological features in the assessment of taxonomic and evolutionary relationships. Evolutionary Systems of classification published by Armen Takhtajan Rolf Dahlgren and Arthur Cronquist have utilized data from embryological sources. Gwenda Davis from Australia published her *Systematic Embryology of Angiosperms* (John Wiley, 1966). Embryological work had been done earlier by I. V. Newman and later by G. Davis, R. B. Knox, N. Prakash and others in that continent. W. R. Philipson has done embryological work in New Zealand. Elsewhere in this half of the world, contributions have come from Japan (K. Abe, Y. Hayashi, T. Hiroshi, S. Takao, H. Tobe, T. Yamazaki, O. Yoshida among others), Singapore (A. N. Rao), Philippines (J. B. Juliano) and more recently from China (S. Chao, Mu Xijin, C. Zhou). From the African continent may be mentioned the contributions of M. P. De Vos of South Africa and in the earlier years of A. E. R. Kadry of Egypt. South American contributions include those of Victor Garcia of Venezuela and of T. E. Di Fulvio and A. E. Cocucci from Argentina.

The untimely demise of Panchanan Maheshwari in 1966 was a great loss to the botanical world. He had conceived

the idea of preparing a comprehensive work on the comparative embryology of Angiosperms and to commemorate his first death anniversary, the Delhi University organized a symposium in 1967 on this subject, the proceedings of which were published by the Indian National Science Academy in 1970. This was the forerunner for the present publication under review, which, as already stated, is in two volumes and is organized in the following format: The Introductory Part (pp. 1–112) gives the background, diagnostic characters, developmental aspects covering the embryological criteria, viz. anther, microsporogenesis, male gametophyte, mature embryo sac, pollination, double fertilization, endosperm, embryo, polyembryony, apomixis, seed and nutrition of anther, ovule with an account of the significance of comparative studies. This part is suitably illustrated with line diagrams, schematic representations and SEM micrographs. The present authors have followed the broader definition of 'embryology' to include all the criteria mentioned above as envisaged by Schnarf, Maheshwari and others. The introductory part is followed by a detailed account of the embryology of the orders of Angiosperms arranged according to the Engler's System of Classification (H. Melchior 1964). 65 orders and 317 families are covered. The first volume covers the Archichlamydeae under the Dicotyledons (pp. 113–614) with the orders Casurinales to Umbelliferae. The second volume deals with the Sympetalae (pp. 615–830) with orders Diapensiales to Campanulatae and the Monocotyledons (pp. 831–1012) with the orders Helobiae to Microspermae and concluding remarks. Under each order, the general features, the main embryological characters of the constituent families and for each family, the relevant bibliography are given. Families which have not been investigated so far are indicated. These family accounts are adequately illustrated and there are some excellent SEM micrographs (F. Bouman). At the end of each order, taxonomic considerations are discussed with reference to the position of the order as viewed by different authors in their systems of classification. An exhaustive 'references' running to 160 pages and a Plant Index complete the second volume.

Prof. B. M. Johri and his associate authors have accomplished a stupendous

task in bringing out these two volumes which document the most significant contributions in angiosperm embryology coming out of laboratories all over the world as outlined earlier in this review. India has made a distinguished contribution. The transformation from the early phase of descriptive studies using light microscopy and rotary-microtomed sections to the present diversified and sophisticated methodologies involving scanning electron microscopy, ultrastructural and biochemical/histochemical observations, DNA sequencing, advanced photographic techniques, etc., have revolutionized research in this discipline. In regard to taxonomic assessments, the traditional criteria thus far employed are giving way to complicated computerized projections. As an illustration, one may refer to the project just launched at the Missouri Botanical Garden in St. Louis, USA for a *Flora of North America north of Mexico and Canada* which will have an electronic data base that will contain 'so much diversified information that scientists will be able to conduct original research in evolutionary biology, ecology, plant taxonomy and other fields simply by using computers to win now and correlate the data'. With all these developments and with the availability of advanced laboratory and photographic equipment and the latest computer technology, the day may not be far off when one can watch 'live' the drama taking place within an angiosperm ovule! and with the press of a button unravel the structure and taxonomic relationships of any angiosperm. This is the scenario for the twenty-first century.

The book under review is excellently produced and printed (type-setting done by Macmillan, India) maintaining the high standards of Springer-Verlag publications. Considering the cost of printing in Europe, the high price of the book is perhaps inevitable but it should not deter any library from acquiring it. It will be an investment that will benefit generations of research scholars, students and others interested in plants and flowers.

Prof. Johri has just completed another monumental, multiauthored book, *Botany in India: Modern Period* which is in the press and is due for release in the summer of 1994. At an age when much younger people 'hang up their boots', Prof. Johri, who is 84 years old, continues to 'wear his', treading the

weary path of botanical writing and documentation. The botanical community salutes you, Prof. Johri.

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**The Golem: What Everyone Should Know About Science** by Harry Collins and Trevor Pinch. Cambridge University Press, Cambridge, UK. 1993. pp. xii + 164. Price £10.95 (hardback). [ISBN: 0 521 356016].

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After quickly going through this book one would think that the authors have said nothing profound and that they have merely described what is observable in the process of doing science. On the contrary, these two sociologists of science have attempted, in a lucid style, to demystify science and to dispel the widely prevalent notions that science is a model of objectivity and rationality and that the scientific method can lead to infallible truths about nature.

The authors want to show that 'there is no logic of scientific discovery or, rather, if there is such a logic, it is the logic of everyday life'. They want the readers to understand that scientists are neither Gods nor charlatans but are merely experts, as human as any other set of experts, and that science is one kind of 'expertise' and not 'certain knowledge'. They aim to demonstrate that science and technology are inherently risky and fallible, although every failure is attributed by the science establishment to 'human error'. They would like the lay public to know more about science than more science, more of the methods than of the content. According to Collins and Pinch, the proper metaphor for science is neither a chivalrous knight nor a pitiless juggernaut but a golem driven by truth, but not really understanding the truth – a lumbering giant who knows neither his own strength nor the extent of his clumsiness and ignorance.

Collins and Pinch try to achieve their goals elegantly by describing the inner workings of science through seven case histories covering past and present as well as physical and biological sciences – the idea of chemical transfer of memory propounded by McConnell