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Flora-Writing Exemplified by Classical, Conservational and Unconventional Models

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Abstract: There are many ways to compile a Flora. The Flora of Turkey is a remarkable 10-volume work completed within a quarter-century of its inception. A review of the factors contributing to the Flora's success is provided. The Flora of Turkey is a classical Flora with an additional supplement recently produced by Turkish botanists. Flora Hellenica is another example of a classical Flora. Some aspects of its background and production are briefly mentioned. Conservationists consider the endemic flora of a country needs protection for all time, and an opportunity arose to prepare a three-volume work on the endemic flora of Greece. The first volume, covering the Peloponnese, was published in September 2001. Flora contributions and monographic work both have their uses. An unconventional model of Flora-writing is presented after the revision of a large family of plants, the *Brassicaceae*. The latter is a wide and diverse group, several members of which are of great economic importance. Biodiversity in the family is unquestionably demonstrated, together with comments on relationships. In summary, a good Flora survives long after the flora has gone.

Key Words: Plant taxonomy, biodiversity, flora, Floras, Flora-writing, relevance, endemism, Turkey, Greece.

I need to begin by making a short statement about the functions of taxonomy, though this may be familiar to many of you. I think this is necessary orientation, whether we like it or not.

Why do we classify?

Classification is what taxonomists basically do. Here are four reasons why:

1. Without recognising objects and naming them we cannot communicate.

2. We need a system in which we can store information and retrieve it swiftly and fully. Systematics is the information storage and retrieval system we have invented. The key to the information is the name. To those who ask us, "What's in a name?", we can reply, "Everything".

3. We have to identify for all sorts of reasons. What is this plant? Can I eat its fruit? Will it grow well in Turkey? What is the chemical basis for its strange smell?

4. Human beings have a built-in instinct. Whatever we do, whatever we are interested in, even if we claim to be interested in nothing, we have to classify. We do it all the time. The urge to classify is a fundamental human instinct.

Let us now summarise the aims and functions of plant taxonomy:

1. To define the kinds of plants there are,

2. To describe, illustrate and name them,

3. To disseminate this information,

4. To provide simple means for their identification,

5. To assemble and curate the system,

6. To maximise understanding of their origin and relationships.

We now need to connect taxonomy with a great buzz-word – biodiversity. Taxonomy defines, describes, names, classifies, stores, retrieves, etc., etc. everything to do with biodiversity in this world, be it wild or cultivated. What is biodiversity? What do we mean by this word which is always cropping up in grant proposals?

We mean:

variation in plants,

variation in habitats,

variation over space (geographical variation) and

variation over time (due to evolutionary change).

How do we know about this variation, this biodiversity? Taxonomic work tells us. There are four well-defined phases to taxonomic work, all of which are still going strong.

First, the pioneer phase. People travel and discover and collect and preserve and bring back for study all the plants they see or hear about. This is sometimes called alpha taxonomy. Of course, the geography and the habitat diversity become known too, if the collectors have done their work properly. This is the means by which we discover the variation in nature and the options for the future.

Phase two is consolidation. Here the collections are compared and described. Names, Floras, monographs and revisions are produced. The information is published and disseminated, as fast as resources will allow.

Phase three is the investigation phase. Now the cytology is looked at: and the anatomy, the biochemistry, genetics, ecology, pollen and breeding systems. There is more morphology, more characters and more evidence of variation, similarity or difference.

Finally, the encyclopaedic phase. Here all the data are put together and interpreted, as well as used in classification. Here the orthodox and the experimental facts are put together. Here are the databases, the taximetric and cladistic analyses, the accounts of evolution and adaptive radiation, the estimations of form and function relationships. This is sometimes called omega taxonomy.

We have a long way to go with all these phases, and we have to put them in perspective.

We now need to look at phase two, the products of taxonomy.

Floras are essentially the useful end-product of taxonomic research. Their origins can be traced back thousands of years to herbals which were an attempt to codify what was known about useful plants, particularly for medical purposes. Floras as we know them have a history of around 250 years. Their main components are already apparent in Linnaeus' Species Plantarum (1753), which provides a fully inclusive list of taxa, synonymy, distribution, bibliography and diagnostic descriptions. From that time on they have evolved with the addition of identification keys, notes on ecology and biology and attempts to provide phylogenetic rather than artificial arrangements of taxa. Modern Floras also usually contain copious illustrations, but this feature also existed in the early herbals. There are probably more Floras available now, or in the process of being written, than at any other time in history.

Let us now look at the users of Floras and see what they want. These are the:

Conservationists, and their paymasters

Crop improvers, and their paymasters

Evolutionary scientists

Resource managers and ecologists

Development managers and planners, plant introducers and relievers of famine

Producers and users of medicines

The educated public, seeking knowledge, understanding, etc.

What do these people want from a Flora? Mostly they want to be able to identify plants they think may be of significance in their work. Any taxonomist knows how many people ask him in any one year to identify plants.

The conservationists need a Flora to identify plants in the areas that are under threat of disappearance following development. Let us take the case of rainforest conservation. In a rainforest conservation area, there are many thousands of species to deal with. That is one problem. Another is that the means of identifying these species are not always very good. Another problem is that many of these species may not have been recorded in that area before.

A further problem is that a proportion of the species there will not have been discovered before, and will be new to science and need to be named and described.

Crop improvers come in many guises – seed firms, chemical companies, plant breeders, genetic engineers and seed technologists, not forgetting farmers, who want better crops more cheaply and from a smaller area. A Flora is needed because any improvement or enquiry into how crop species evolved or originated needs information on wild relatives and the areas they occupy. A good Flora indicates where and what germ-plasm diversity may reside, waiting to be exploited.

Resource managers and ecologists need Floras for identification. They need to know the names of plants that are useful to them in the areas they are working in, or plants which may be useful to them, or are reducing the worth of whatever it is they are managing, or researching.

Developers of undeveloped territories, where there are macro-economic problems, use plants to solve these problems. They introduce suitable plants from elsewhere. They plan future economic systems from extrapolations of existing ones involving these plants. For this work they need reliable names, reliable lists of plants, reliable collections, reliable observations, reliable synonymy and good keys. In other words they need to identify their plants from a reliable Flora and databases.

Plants that may have a medicinal use attract drug companies which sincerely want to be rich. There is a lot to extract from a good Flora which gives reliable identification and localities. Ethnobotany generally is greatly dependent on Flora-writing and taxonomic works.

The educated public, with plants in their gardens, want their plants to have names. They want to know what they are, what they are related to, what diseases they suffer from and whether they are frost-hardy. They spend a lot of money every year on books to identify their plants. If they cannot use the Flora they look for a taxonomist. Some of them become amateur taxonomists of formidable skill.

So we can see there are many users of Floras. Floras are a mechanism for delivering concise information about the plants of an area in a condensed, comparable manner. The key features are comprehensiveness (all taxa in the area under consideration are accounted for), conciseness (descriptions are diagnostic, delivering only information necessary for unambiguous identification), comparability (related taxa have descriptions and other data which are readily comparable), identification (various means, usually dichotomous keys, are provided to allow users to identify unknowns), distribution (either in the text or maps or both to describe distributional patterns) and biology (a concise summary of phenology, reproductive biology, ecology and perhaps other added features). Floras are designed to be used by those who require a summary overview of the plants of a region. They should provide sufficient detail to enable identification, and beyond that, should pack as much subsidiary information as possible into as small a space as possible. Most importantly, they should point to areas of uncertainty (distribution, delimitation or relationships) and to other more comprehensive literature. Most good Floras do all these things. Users of Floras do not expect to find all the available information about a taxon, but they do expect a well-written summary or overview of all the information. A good Flora gives the feeling it is packed with informative detail without excessiveness.

Floras commonly take five to 25 years to produce. Monographs are written for a different purpose. Depending on the size of the group, these can take a year to a life-time to produce. They are discursive, they can be comprehensive, and they may cover areas beyond the scope of Floras. They are usually delimited by taxonomic rather than geographic scope.

Revisions are a form of monograph, covering only restricted areas. These too take many years to achieve for any reasonable size of group.

Monographs should provide detailed descriptions of the taxa covered, even if these descriptions run into many hundreds of words. They are an opportunity for a researcher to deliver data on all the characteristics of a taxon, not just its diagnostic characters. They provide an opportunity to discuss in great detail variability, ecology, biology, hybridisation and other features of breeding systems, and relationships in minute detail. Nomenclatural matters can be explained, as well as typification and validity. Nowadays, monographs include extensive discussions of phylogeny, with all their extensive phylogenetic trees, although I think many people prefer to look at real trees, not phylogenetic ones.

Compared to users of Floras, users of monographs want and expect all the available information on the taxonomy of the taxon to be provided, summarised or referenced.

Floras and monographs are therefore at the opposite ends of the spectrum. Monographs provide the detail and Floras provide the overview. Both are necessary, and each serves a purpose. Thus you can sometimes find three different revisions of the same genus. The fact that three different botanists (or groups of botanists) have three different views on the taxonomy of a group is unfortunate for users, but shows clearly to us that taxonomy is not only a science but also an art. There is no absolute truth, just as there is no absolute correct system

of classification. To classify books by their colour, whether red, blue or yellow, is no more incorrect than to classify them by their author or subject. It may be a good classification, it may be a bad classification, but it is not an incorrect classification.

What other products of taxonomy are there? There are biosystematic monographs and chromosome number reports, which slowly accumulate. Users are mainly uninterested in these so there is little financial support forthcoming. On the other hand, checklists, keys and popular books on identification – these are quick and cheap to produce. They find a ready market with users. These are more and more based on old research that it has not been possible to re-examine due to lack of funds and trained personnel. Yet they are churned out because there is a real demand and a real need.

Another product is the database, the electronic delivery of botanical information; a compendium of everything known, in a computer program, about a group of plants. The data is stored on a format basis and is updated as long as the money and personnel to operate the program exist. The data can be sold or exploited for making other kinds of taxonomic product (for example, in quantitive biogeography). Databases have been the only area to receive reasonable support over the last 20 years.

What about the producers of Floras? Who are they?

Universities: In universities, people must hear about taxonomy, know what it is, what it does and why, and become interested in it and attracted by it. Universities have a major research function to produce the products of taxonomy. However, they often have no money to do this, and university taxonomy and Flora-writing have as a result been very under-productive.

Botanic gardens, institutes and museums: the main output of Floras should be from this source as it is here that professional taxonomists are employed.

There are also gifted amateurs, often wealthy individuals. The best of these have close contact with universities, botanic personnel and resources, and are extremely good. George Bentham was an amateur and he was certainly very productive in Flora-writing.

The economics of Flora-writing

Plants are important. Plants can deliver freedom from want. Plants underlie civilisations. How odd it is that so few governments in the world invest in plant taxonomy. The trained taxonomic workforce has declined, as has the rate of production of new taxonomists. Yet there has been no decrease in what needs to be done and done urgently. When you make a comparison with heavily supported, expensive astrophysics research: "The stars will still be here to look at in a thousand years time, but many of today's species will be gone in only ten years". With universities denied the resources to produce taxonomists, the university contribution to Flora-writing has also declined in scale and speed of production. Work guided by random opportunities of funding has replaced the solid work that should be the academic contribution of a university to society. Short-term research is the enemy of serious taxonomic advance. The quality Flora never appears. Cheap and cheerful Red Data picture books dominate the market.

So what can we do? We must demonstrate that modern techniques are available and offer well-focused projects with distinct, declared aims that have a recognisable end-product advantage for the user. We need to demonstrate the relevance of Flora-writing and seek commercial subsidies for fundamental research.

So much for this long introduction as to why we should be involved with Floras and Flora-writing. In general, taxonomists nearly always love their work (and their plants) and live long and happy lives. I will now illustrate Flora-writing with three different models – the classical, the conservational and the unconventional.

The Flora of Turkey was published in 10 volumes (1965-88) running to over 7200 pages. Brittonia has written that "no botanical library can afford to do without this admirable Flora", though with current prices it may also be true that few botanical libraries can afford this admirable Flora. It is widely acclaimed as "a magnificent achievement" (*New Phytologist*); approaching the "Perfect Flora" (*Israel J. Botany*), and each volume has always received extremely favourable scientific reviews. Volume 1 was published in 1965, Volume 9 in 1985 and the supplement (Volume 10) in 1988. Thus this great enterprise was completed approximately within a quarter-century of its inception. The Flora of Turkey is an example of a classical Flora and has an additional supplement recently produced by Turkish botanists. What has contributed so greatly to the Flora's success? I published a review of the factors many years ago, and the most noteworthy of these are now mentioned.

1. Format of the Flora

The format strikes the ideal happy medium between the brief type of Flora and the encyclopaedic. There is sufficient detail in may the Flora of Turkey to interest the serious researcher without being over-exhaustive and therefore boring for the plant collector, field botanist or dedicated amateur.

Putting in too much detail runs the risk many Floras face – never to be completed.

Here is a slide which indicates Floras in full swing or in the course of preparation in 1972. It is interesting to note how many or how few of these are completed now, 30 years on.

The publicity folder of Flora Iranica states that it is expected to publish the whole work within 10 years! An important feature of Flora-writing is a realistic completion date. It is up to the team leader to keep the momentum going so that the target date can be achieved, or at least almost so. This is necessary not just for the morale of the team members, but also for the body which is funding the project as a whole. The latter must know that they are committed to spending for, say 25 years, and that they are not committed beyond that time unless some emergency beyond the team's control causes the time-scale to go wrong. The Flora of Turkey was successful in that respect. It was once described in a review as "regular as a metronome," with one volume appearing every 2-3 years on average, with an occasional longer or shorter hiccup. This speed of production in current research Floras is now greatly aided by electronic methods.

Several features within the Flora format are now highlighted.

1. Circumscription of species

This is reasonably conservative and does not show too much variation in different accounts by different authors for the most part. The species concept is neither too broad nor too narrow for most taxonomists' liking.

2. Description of species

These were originally designed to be models of "concise detail". The 80-100 word limit of most of them allows a fairly full yet concise description of the plant.

3. Innovations

The Flora is receptive to new ideas, which renders it more usable. For example, within the Apiaceae, the limits and relationships of the genera are so problematical that a tribal classification cannot easily be adopted. As a departure from normal practice, a multi-access key to the genera was constructed to supplement the usual indented dichotomous key. The introduction of such a key in Volume 4 is, I believe, the first envisaged for any Flora. It proved so successful in facilitating the identification of genera in large Angiosperm families that the idea was continued in the Asteraceae (Volume 5), which includes over 1150 Turkish species in more than 130 genera, and also in the Poaceae (Volume 9).

4. Citation of literature

This is extremely important for the user as it speeds up further research. Valuable time is saved instead of hunting all over again for references. The facts in the Flora were checked by going back to *original sources*, whether of plant specimens, type citations or volume and page numbers.

5. Typification

This has been attempted for all taxa except the Linnaean ones. Type citations are essential in any research Flora, as opposed to the situation in a *checklist*.

6. Selected specimen citations by a grid system

This was rather a novel idea back in the 1970s; it also helps the reader to assimilate the distribution of taxa quickly. We are fortunate in that Turkey is the ideal shape for a rectangular grid system!

7. Habitat and ecological notes

These are given for all taxa (including aliens), at least in the later volumes, not only for selected taxa.

8. Critical notes and observations

These, at the end of the species description, reveal what we still do not know and suggest avenues for further research.

9. Indices

Some users of Floras have commented that the best test of a Flora is its index! In the Flora of Turkey there is comprehensive indexing in each volume, and also to the set as a whole.

II. Some technical aspects will now be mentioned.

1. First, proof-reading by the editorial team has been of an extremely high standard.

2. Secondly, Edinburgh University Press was responsible for the technical production of the volumes.

They have provided high quality printing and binding. Strong binding is essential for a Flora which is meant to be heavily used in the herbarium or the field for a number of years.

III. The facilities

In Edinburgh, where the Flora of Turkey was based, there was immediate access to the excellent facilities of the herbarium, library and garden, which combine to provide a first-class base for floristic research. There were scientific staff to collaborate with and ancillary staff to look after living plants and mount specimens. There is a fine Alpine House for growing material collected in the wild for chromosome counts. The libraries of Kew and the Natural History Museum (London) are reasonably accessible, or literature can be requested on inter-library loan.

The importance of a good library to the making of a first-class Flora cannot be over-emphasised. A good Flora can never be written remote from a good library and herbarium.

IV. The raw material of the flora

Numerous botanical excursions to Turkey were made and field knowledge, together with the thousands of specimens brought back, contributed greatly to the project. A good long-term Flora should be able to stimulate other botanists to do fieldwork in the territory concerned, and this is certainly true of the Flora of Turkey. We have had some marvellous contributors who have assisted greatly in lending us material from their own collections for the preparation of the Flora of Turkey, e.g., Arthur Huber-Morath (Basel), Friederike Sorger (Vienna) and Turkish botanists, many of whom are here today.

V. The Flora team

The success of this remarkable 10-volume work owes a great deal to the Flora team. This was a small, dedicated three-person team driven by someone with a deep sense of commitment and leadership. Peter Davis, the leader, first went to the Levant before the Second World War and visited Turkey in 1938, at the age of 20. Seeing the need for a modern Flora, he determined to make this his main research activity, and many expeditions followed which resulted in a magnificent herbarium collection of Turkish plants. "The botanical community is deeply indebted to Professor Davis, who initiated a noble project, orchestrated its complex realisation with single-minded zeal, wrote a substantial portion of the text and contributed enormously to the raw material of specimens on which it is based".

The assistants. They were diligent and hardworking and together helped Peter Davis complete the Flora of Turkey in 10 volumes. Since the whole team was based at the same institute in Edinburgh instead of being scattered at different remote centres in one or more countries, there was good communication. The process of editing, sending manuscripts for typing and receiving them for checking was therefore at maximum efficiency. However, nowadays manuscripts can be created from research to final stage as rapidly in various institutes by electronic communication.

There was also consistency of editorial judgement, both for in-house accounts and the way external contributors' accounts were hacked into the standard Flora format. A Flora needs to be tightly written and edited to provide a concise overview. It helps to employ a good editor who is permitted to overrule decisions made by a board. This sometimes never happens, and as a consequence the Flora suffers.

Flora Hellenica is another example of a Flora written in the classical style. It is planned to cover all the native and naturalised species of vascular plants in Greece, with emphasis on the native flora. It summarises and collates data which have acccumulated over a long period of time, and includes the elements normally associated with a modern critical descriptive Flora, such as diagnostic keys at all taxonomic levels (family, genera, species, subspecies), typification, synonymy and descriptions based on actual specimens from the area, as well as notes on ecology, geographical distribution, variation and affinities, an index and bibliographical references.

The sequence of families, genera and species in Flora Hellenica follows *Flora Europaea* except when compelled to deviate. A relatively broad taxonomic concept is favoured. The Flora of Turkey cites selected specimens according to a grid system; in Flora Hellenica, specimens other than types are seldom cited, only when a species is very rare or under discussion for variation. The Flora of Turkey includes line drawings, especially of diagnostic features. Dot maps were sparse for the first volumes, but more numerous in the later ones. In Flora Hellenica illustrations have been omitted, but the endemic taxa are

catered for in a separate illustrated work. Dot maps are included for all taxa. These are printed in two colours, six maps to a page, in A4 format in a block at the end of the volume. These dots are automatically generated from a floristic database storing more than half a million records. The structure of this database, established as early as 1988, is designed for simplicity. It is now a powerful tool in the Flora Hellenica project and in quantitative phytogeography.

Flora Hellenica was preceded by Mountain Flora of Greece, published in two volumes in 1986 and 1991. This covers nearly one-third of the species in Greece and resembles Flora Hellenica in style and format, including the provision of chromosome numbers when known. There are diagnostic line drawings and fairly detailed information on internal distribution, but no maps.

We have previously used the term "endemic" for certain taxa, which means they are "restricted to the particular geographical area where they have evolved", be it a country, an island or a mountain range. Conservationists consider that the endemic flora of a country needs protection for all time, and an opportunity arose to prepare a three-volume work on the endemic flora of Greece, supported by the Carlsberg Foundation in Copenhagen. The purpose is to produce an account of all species and subspecies of vascular plants that are endemic to Greece. Three volumes are envisaged . The first deals with the Peloponnese and was published in September 2001. The second will cover the rest of mainland Greece, and the third, Crete and the islands.

The total number of species in Greece is approximately 5800. This is surprisingly high for such a small country in Europe. Of these, about 730 (around 13% of the flora) are endemic. Endemic species are often of considerable taxonomic and phytogeographical interest. They belong to two broad categories – palaeo-endemics and neo-endemics.

You must not think that all endemics are rare or threatened. Indeed some of them are among the most common and most characteristic species, especially on Crete, e.g., *Phlomis lanata, Ebenus cretica, Verbascum spinosum* and *Veronica glauca*. On the other hand, there are also species on Crete whose known occurrence in the world is restricted to less than 150 individuals. Examples are *Onobrychis sphaciotica* and *Nepeta sphaciotica*. Such species may well become extinct owing to breeding collapse, even if the habitats they occupy are not further disturbed.

It has often been pointed out with some alarm that the question of conservation is particularly urgent. Grazing is often believed to be a major threat, but this is a natural environmental factor which has existed for thousands of years. Plants are either able to withstand it, escape it or even depend on it. For the mountain endemics, most are perfectly safe. Overgrazing might threaten the existence of a few, very rare species on Crete and in the Peloponnese, but in general plants face extinction only if they consist of one or a few very small populations, i.e., if they are threatened only by their rarity.

You may well ask why such a work as The Endemic plants of Greece should be necessary. As we have pointed out, because there are so many endemics in the Greek flora, conservationists tend to paint an alarming picture as to the case for protection. Yet unless you know something, or quite a lot about these plants, you cannot take any intelligent steps towards protecting them. Five hundred and twenty of the endemics were listed as on the Red Data "endangered list" by the Council of Europe in 1986, i.e., they are rare or threatened. However, no one at the moment knows the nature or extent of the threat, whether it is real or imaginary.

We would like to collate information, both published and unpublished, scattered or widely available, in order to have a scientific basis for knowledge of these endemics. It is a good idea to see these plants in their native habitats, study their ecology and distribution (fieldwork), study their closest relatives and affinities (taxonomy, cytology) and see if they are growing or going (investigations on seed dispersal, viability, germination, pollination biology, etc.). Only then can the data, be they original or intelligently evaluated and compiled, be used on a sound and scientific basis. Unless we know what plants belonging to a particular group can be found, or had once existed, in a given definite area, and how to identify and name these plants, we cannot go any further in talking about conservation, natural resources, cultivation or education.

It is a good idea for a work to be both functional and decorative, so 111 colour plates have been commissioned

for the first volume. Two statements to bear in mind are: "A picture is worth a 1000 words" and "If you could write it in words there would be no need to paint". It is important that Flora projects write sufficient money into their budgets to cover extensive illustrations.

I must not finish without mentioning the future role of Floras in the delivery of botanical information, in particular the question of hard-copy publication versus the electronic form. It is frequently claimed that books are out of date as soon as they are printed. Electronic delivery offers the advantage of daily, hourly or annual updates. However, taxonomists need to know exactly who said exactly what, and exactly when. Updatable texts are thus in strong conflict with this idea. I think that the traditional Flora should always be a printed account. Printed works are in fact perfectly updatable. If errata or additions accumulate to an unmanageable level, then a new edition can be published.

I will now end with an unconventional model of Flora-writing for a family of plants, the *Brassicaceae*. The Crucifers form a rich and diverse group, several members of which have great economic importance. Biodiversity within the family is unquestionably demonstrated together with comments on relationships. In summary, a good Flora survives long after the flora has gone.

Note: this third part of the lecture was published together with the accompanying colour illustrations as a separate book.

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