WRITING A SCIENTIFIC REPORT

"The question is," said Alice, "whether you can make words mean so many different things."
"The question is," said Humpty Dumpty, " which is to be master - that's all."

Lewis Carroll (1871) *Through the Looking Glass*.

1. Introduction

Scientific information is communicated in a variety of ways, through talks and seminars, through posters at meetings, but mainly through scientific *papers*. Papers, published in books or journals provide the main route by which the substance of scientific findings are made available to others, for examination, testing and subsequent use. Over time the scientific paper, has developed into a fairly formal method of communication, with certain structures, styles and conventions. These mean that information is presented in a standardised way, and hence particular bits of information can be extracted more easily.

Here, we will examine the structure and conventions of a biological paper, using an example (of a field study of the territorial behaviour of a damselfly), to illustrate the typical form and content. Of course papers vary in their exact requirements, and no one example can cover all the possibilities. Read recent papers in a relevant subject area and analyse what styles and structures they use, and which work best.

The structures and conventions discussed below are not rules and should be flexibly interpreted, under the guiding principle that the aim is to present the information as clearly, concisely and unambiguously as possible. Although taking the scientific paper as a model, the principles here apply equally to other, less formal project write-ups and reports.

2. The structure of a scientific report

The normal scientific report has a standard structure (parts in parentheses are optional):

1. *Title*
2. *Abstract / Summary*
3. *Introduction*
4. *Methods*
5. *Results*
6. *Discussion*
7. (*Acknowledgements*)
8. *Literature cited*
9. (*Appendix*)

2.1 Title

Although not really a section of the paper, it is worth giving the title some thought. Aim for something that gives a fairly specific description of the topic of the paper, and possibly the essential result, but without being too long.

> Diurnal changes in the depth distribution of copepods in lakes with and without planktivorous fish: evidence of a predator avoidance mechanism?
>
> An experimental study of the effect of food supply on laying date in the coot.
>
> The distribution and altitudinal limits of bracken (*Pteridium aquilinum*) in the North York Moors National Park.
>
> Reverse transcription-PCR detection of LaCrosse virus in mosquitoes and comparison with enzyme immunoassay and virus isolation.

The important thing to note is that the titles contain a good deal of specific information - you have a pretty good idea what the paper is about before you read it. Avoid vague titles such as ...

> A study of damselfly behaviour

... when in fact you have looked at is the mating and oviposition behaviour of damselflies of a particular species in relation to the current speed in different areas of the river and what you want to say is ...

> The influence of river flow rate on mating behaviour and oviposition in the damselfly *Calopteryx splendens*.

But don't put irrelevant specific information. It might be irrelevant to say that you did your study in a particular river - for the question you are asking it is not important. The reference to the North York Moors above, however, is relevant because the study is of an area-specific problem (the study is primarily of use to people who want to know about bracken in that area).

2.2 Abstract / Summary

The purpose of an abstract is to present a factual summary of the main purpose, results and conclusions of the report which is short and makes sense on its own. Often it is best (and some journals require it) to do this as 3-6 numbered points comprising some, or all, the following:

- The scope and purpose of the study
- Methods (not always necessary)
- Result 1
- Result 2 ...
- Conclusion

e.g....

> 1. The territorial behaviour, mating frequency and oviposition of *Calopteryx splendens* (Charpentier) (Odonata: Calopterygidae) were studied in relation to the water flow rate in the territories (weed patches) of individual males.
>
> 2. Weed patches with faster flow rates appeared to be preferentially selected by males, and more vigorously defended. Weed patches in slow or still water were often unoccupied. Experimental reduction of flow rate in individual patches caused males to desert previously defended territories.

3. Males had greater mating success on territories with higher flow rates and more ovipositions were observed in these patches.

4. It is not known why weed patches with faster flows seem to be better quality sites for *Calopteryx* oviposition, but possible reasons include higher oxygen levels for developing eggs and better protection from egg parasitoids.

2.3 Introduction

The introduction should:

- set the background to the question, using the literature (Why is it interesting / important?)
- state the question, hypotheses and predictions. (What are you investigating?)
- briefly state what the study does (What is in this paper?)

Start with brief general statements to put the study into its broader context ...

> Oviposition site selection by female insects can be a critical factor in offspring survival, and hence fitness (Smith 1981). In some insects, notably many of the Odonata, males occupy or defend oviposition sites and mate with arriving females before allowing them to oviposit at that site. Males in such systems benefit in two ways from defending high quality sites: mating with all females ovipositing at the site ensures their offspring will have higher survival, and by occupying high quality sites, they will have access to more females (Jones 1976).

Then move on to more specific detail about the type of system ...

> In calopterygid damselflies females oviposit in the submerged stems of aquatic plants in streams and small rivers (Hines 1956, Norman 1968). Males defend patches of weed .....

Then develop the question ...

> ..... It has been repeatedly observed that many weed patches are always occupied and are the subject of much territorial dispute amongst males, whilst others remain unoccupied or uncontested (Gateman & Nunn 1978, Speake 1982, Mollison 1987). This suggests substantial differences in patch quality, but the basis of this difference is not known. Since the larvae may disperse after hatching, the underwater environment of a weed patch seems most likely to be important for survival and development of the eggs. One important physical factor which could influence the environment in a weed patch, and which may vary considerably in different parts of the river channel, is flow rate. We therefore hypothesised that flow rates could be an important determinant of patch quality.

Say what the study actually does ...

> In this study we investigated the physico-chemical differences between 'good' and 'poor' quality patches of weed as defined by the behaviour of the damselfly *Calopteryx virgo* Linnaeus. We also tested the assumption that males on more vigorously defended patches have greater mating success.

Don't separate out the question, hypothesis and predictions as special statements in bold or whatever, or put them under separate headings. Although they are vitally important to the way you do your study they should simply appear where necessary as part of the normal text.

A note on presenting species names

A final thing worth noting, as there is an example of it in the passage above and often you will need to deal with it in the introduction, is the correct way to present species names. This causes a great deal of trouble, largely because it is not always appreciated that specific meaning attaches to the conventions used for presenting species names. You will see that the name above: "*Calopteryx virgo* Linnaeus" has several distinct elements in its presentation (italics, upper case initial letter(s) etc..). These matter. The full meanings of each of the various elements you might find in a Latin name are too extensive to cover here, but the following guidelines should cover most situations.

Presentation of common names is less fixed by convention that of Latin binomials but, in general, common names are written with lower case initial letters unless the name itself contains a proper name [e.g. Norway spruce]. Common names are written in the same typeface as the normal text.

Common names can be used in reports, but the Latin binomial is a unique identifier that provides a standard, internationally recognized, label for a species. A report should always include the scientific name of the species you are dealing with.

Obviously you should ensure the scientific name is spelled correctly. Fortunately "systematists' Latin" is fairly simple phonetically, but nonetheless it is best to check the name from a reliable source when writing it for the first time if you have only heard it spoken (try searching for 'Calopterix' on the web!).

So now the spelling is right let's look at the parts of the name and how to present them...

Calopteryx virgo

<u>Calopteryx virgo</u>

The first name (the genus) should begin with an upper case letter, and the second name (the species) should begin with a lower case letter (always – this is not a style choice, it is a rule!). Both genus and species names are usually written in italic type, but may sometimes be written in normal type and underlined. This is because they are Latin (or a form of it) and it is conventional when using a word directly from another language to italicise it (hence you often see terms such as *per se* or *vice versa* in italics). Underlining is an alternative (<u>*don't use both together*</u>) which derives from the fact that single underlining is the printer's instruction to a typesetter to set the text in italic, and in the days before word-processors italicised text was tricky to produce on a typewriter.

Sometimes there will be more than just the genus and species names …

Calopteryx virgo (Odonata: Calopterygidae)

The names on the right (though they could equally well be on the left) are the higher taxonomic classification (order and family in this case) and are sometimes presented to enable a reader to easily place the organism – just having a species name is not always very informative unless you know what group of organisms is under discussion. These are written in normal text, but with an upper case initial letter [N.B. just to confuse things though, if you write the informal derivative version of such names – such as 'odonate' or 'calopterygid' (for example, "… and calopterygids, unlike other odonates,…") then they have a lower case intial letter]. If, as is occasionally the case, you have a

subspecies of an organism (e.g. *Calopteryx splendens xanthostoma*) then the sub-species name (*xanthostoma*) is formatted the same way as the species name.

In the passage above you will notice that the name of the damselfly is followed by a name: 'Linnaeus'. This is the authority, the name of the taxonomist responsible for naming the species. Unfortunately, taxonomy changes as groups are revised and new classifications developed, and so species names are often not the same as they were originally given. This results in a complicated system of having more than one authority, dates, and authorities appearing in different sorts of brackets and parentheses, sometimes abbreviated, sometimes not…

Calopteryx virgo Linnaeus 1758

Calopteryx virgo L.

Calopteryx splendens xanthostoma (Charpentier)

Althea rosea (L.) Cavanille

To present things correctly in a report you don't need to know exactly what all these different arrangements mean, but the important thing to remember is that things like the arrangements of parentheses, abbreviations, do mean something specific – don't just stick them in to make it look tidy. And when authorities are abbreviated (e.g. Linnaeus to L.) these abbreviations are fixed, don't just decide to abbreviate an authority yourself to something that looks sensible. If you need these esoteric details then copy them carefully from a reliable source.

When should you include the authority? In scientific paper it is conventional to include the authority when the species is first mentioned (in the main text not the abstract), and leave it out thereafter. However, for most other purposes you are unlikely to need to include the authority.

Finally, abbreviation of names. Once you have given the full name of a species it is often convenient to refer to it in an abbreviated form later in the report…

Females of *C. virgo* were regularly observed …

Note that there is only one correct way of abbreviating the name – to shorten the genus to its initial letter (plus full stop) and keep the full specific name; never do the reverse (*Calopteryx v.*). If there is a subspecies name then you can abbreviate both generic and specific names, e.g., *C. s. xanthostoma*.

2.4 Methods

The Methods section (often called Materials and Methods) should provide enough information about how the study was carried out to enable the reader to evaluate the validity of the results.

- What was done?
- Where (usually necessary for field work) ?
- When (may be necessary for seasonally dependent studies) ?
- Why (may be necessary to justify the use of a particular approach) ?

You may have been told, at various times, to write the methods so that someone could repeat what you have done exactly from your account alone. This is OK in principle, but often takes an excessive amount of space and shouldn't be the overriding principle. The emphasis should be on giving the reader sufficient information to evaluate your results; i.e. it doesn't matter that you sorted your sample into Petri dishes, or

which make of microscope you used to do it, but it does matter that you worked at ×20 magnification, because that may determine how likely it is that you missed very small items. The main exception to this is if you are reporting a novel technique which other people are likely to want to use, where more detail than normal might be required.

Be concise. You do not need to explain the details of standard procedures. If you are using a procedure described by someone else then summarise the essential features and just cite the reference for the method. In the Methods you do not usually need to state which statistical tests you have used, unless they are non-standard or require particular discussion (for example you may wish to state that the data were transformed before analysis). Similarly, you don't need to state what statistics package you used for standard statistical procedures (all those in this course are standard). Avoid 'padding' sentences such as ... " The data were analysed statistically and by plotting graphs to see what the results were."

The standard style in scientific reports is to write in the third person ("`Experimental plots were marked out ...`" rather than "`We marked out experimental plots ...`"). This is one area where the accepted conventions vary between different areas of biology. In some the use of the first person, where it enhances readability of the text, is permitted, and even encouraged. In others it is not. In general (and if unsure) it may be safest to stick with the third person approach, however, if it is acceptable in the subject area in which you are working, judicious use of 'I' or 'we' can improve the clarity and readability of your text and may be used where appropriate. Also try and use the active voice; "`It was found that males always defended single weed patches`" could be replaced with ... "`Males always defended ...`".

A final point is that if you have several experiments, or sets of observations, in a study you should use appropriate subheadings to make it easier for the reader to follow, both within a particular section (such as the Methods) but then also using the equivalent subheadings to organise the Results and possibly the Discussion. e.g.

```
MATERIALS AND METHODS
   Study site
   Territory occupancy by males
   Oviposition behaviour
   Experimental manipulations of flow rate
```

2.5 Results

In the results you are aiming to provide a clear account of the material factual findings of the investigation, using a combination of text, summarized data, and figures (graphs). If you have described different parts of the study under different subheadings in the Methods, then use the same subheadings (where relevant) to organize the Results.

Results are presented in a variety of different ways:

Text. The *text* part is important. You must include clear statements of the results. No result should just be presented just as a figure or a table with no corresponding statement in the text, you need to lead the reader through the information, bringing out the important features. (This does not mean that you should duplicate information in text and figures, or tables, but if a figure is used then there should be a reference to that figure in the text, which summarizes the result).

Males behaving in a territorial manner to other males were observed at least once on 60% of the weed patches in the study area during the main period of observation, and slightly under half of the patches were more or less continuously occupied by territorial males (Table 1).

The rate of oviposition events was positively correlated with the mean flow rate recorded for a weed patch (Figure 2).

Data - Numerical data are normally presented in tables, though occasionally in the text, but in either case usually in summarised form only (e.g. means and standard deviations).

Table 2. The flow rates of the manipulated patches, and mean simultaneous number and turnover (number of different males per day) of territorial males on experimental patches. (Values in parentheses are standard errors for each mean.)

Experimental treatment	Mean flow rate ($m\ s^{-1}$)	Mean number of males per patch	Mean turnover of males per patch
Increased flow	0.45 (0.11)	1.2 (0.22)	1.2 (0.4)
Control	0.18 (0.09)	0.9 (0.21)	3.1 (0.6)
Decreased flow	0.02 (0.01)	0.1 (0.03)	5.9 (0.9)

Raw data may be appropriate if there are very few data, or you need to discuss the values of specific data points - but this is rare. Don't include big tables of your raw data. If it is important to include the raw data (usually only the case if the data set may be of use to others as a basis for further analyses) they can go in as an appendix.

Statistical summaries - the results should be where most or all of the statistical results appear. There are three places to include summaries of statistics:

1. In the text ....

The mean flow rate in patches of weed continuously occupied and defended by males was significantly greater than that for unoccupied patches (t=2.73, d.f.=28, p<0.05) (Figure 1).

2. In figure legends ....

Figure 2. The relationship between flow rate and the number of oviposition events for 18 patches at the main study site (r=0.57, n=16, p<0.05).

3. In tables (if there are large numbers of tests to present which would clutter the text), e.g. if you have an analysis involving 10 regressions of the same kinds of variables (e.g. body weight and heart rate) for a number of different taxa, then it may be convenient to summarise the slopes, intercepts and significance of the relationships in a table rather than trying to put all ten in the text.

NB - If you do a standard statistical test by hand, you do not include the working of the test in the paper - just the result.

Figures. Any type of graphical presentation is a *figure*, but *figures* and *tables* are different. All figures and tables must be referred to in the text of the Results (or elsewhere). Reminders:

> *Tables* have the legend at the top .. horizontal lines (not boxed in) .. and are labelled: `Table 1`, `Table 2`, etc. (example above)
>
> *Figures* should have a legend at the bottom and be labelled: Figure 1, Figure 2, etc. (example below)

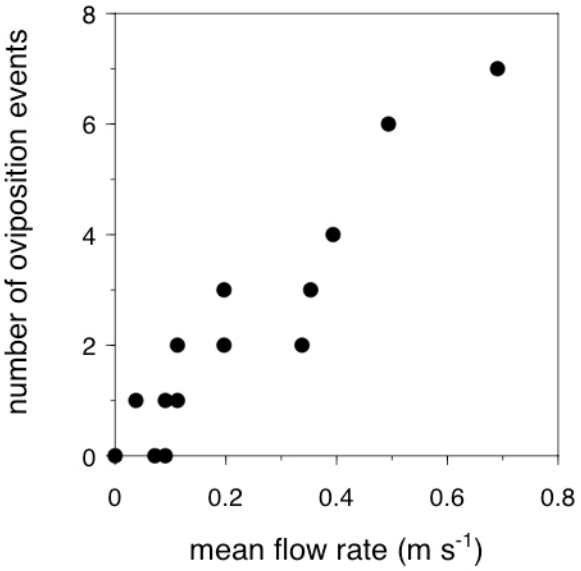

Figure 2. The relationship between flow rate and the number of oviposition events for the 14 weed patches at the main study site ($r=0.94$, $d.f.=12$, $p<0.001$).

With the advent of sophisticated word processing systems, and the increasing rarity with which people produce figures by hand, it has become relatively easy to incorporate tables and especially figures directly into word processed documents. If you are writing a report which is not going to be typeset, then this allows the production of very professional looking documents. However, if the material you are writing is for publication, then the printers will usually require the text and figures, (and sometimes tables) on separate pages, and in general it is easiest to produce your documents this way. Insert the page(s) containing a the figure(s) immediately following the first point at which the figure is referred to in the text. The other thing to beware of in incorporating figures into text in a word processed document is that you will generate very large files - text doesn't take up much storage space, but graphics do. You can quickly end up with a file that is too big to e-mail readily. Microsoft Word documents are prone to becoming extremely large when graphics are included. If this becomes a problem for submitting information electronically you can convert the document to the much more compact Adobe PDF format.

You cannot edit this format, but it is a universally acceptable way of producing electronic documents, which can be read on a wide variety of computer systems.

What should not be in the results: discussion of the meaning or biological implications of the results.

2.6 Discussion

The function of the discussion is to consider the meaning of the results and the light they throw on the original question; to assess the results in the context of other studies; and, if appropriate, to consider the limitations of the work and future directions for study.

It is common, and usually helpful, to start the discussion with a short paragraph, or so, summarizing the results. e.g.

> Calopteryx females exhibit a distinct preference for weed beds in faster flowing water as oviposition sites. Males recognise such good quality sites and occupy and defend them against other males, ignoring weed beds in slower water. This results in more copulations for males which occupy the fast flowing sites. The assessment and response of males to flow rate changes can occur within a few hours.

Consider the whether the results support the hypothesis or suggest it requires modification or rejection. e.g.

> The male damselflies' preferential occupancy and vigorous defence of weed patches with faster flow rates, combined with a clear positive relationship between flow rate and oviposition frequency, provides strong support for the view that the underwater environment is an important determinant of oviposition site quality.

Discuss the limitations of the study and the appropriate direction for further work - but these may not be required - and if they are appropriate they should be brief and to the point.

> Although the results do implicate flow rate as a determinant of oviposition site, it is not clear whether females are responding directly to flow rate, or whether males are assessing flow rate and females are selecting the higher quality males (presumably those that occupy the best patches) assessed in some other way. This would require a separate experiment where females were allowed to select oviposition sites in the absence of males.

Don't just grumble and don't make stock criticisms without good reason (e.g. don't automatically say it would have been better to have a larger sample size - it may be true, but it may not - large sample sizes don't solve everything). There may be unresolved, or unresolvable, problems, and you need to be honest about these, but you also need to be positive - if you don't seem to be sure that it is worth reporting how will anyone else be convinced? A report <u>does not</u> require a section headed "Experimental Error". Similarly don't attribute any problems you can't explain to 'experimental error' - everyone knows measurements can't be perfect - it is a meaningless term.

Finally, bring out the wider implications (be realistic about the significance of your work) and future directions, e.g.

> These results indicate selection of oviposition sites, by females, on the basis of flow rate, but the reasons for such selectivity are not known. Flow rate has been implicated in other studies of aquatic insects as being of importance for preventing low oxygen conditions developing (a stress to which developing eggs may be particularly sensitive) (Armherst 1989). High flow may also reduce the ability of egg parasitoids to search the plants (Girton and Jenner 1976). A critical part of assessing the basis of site choice, and evaluating the role of the underwater environment will be measurement of egg and larval survival in weed beds of different flow rates.
>
> It seems likely that the patterns observed in *Calopteryx* in a single section of the river may also be important in determining choice of habitat between different river sections or even different rivers with high or flow rates. This also raises the unwelcome possibility that quite subtle changes in flow caused by water abstraction and river regulation (a problem on a neighbouring stream to the study site) could cause marked interference with *Calopteryx* breeding and even loss of the species from a river system.

What doesn't go in the discussion: new results (except occasionally for small additional analyses of the data that have arisen as a direct consequence of interpretation of the main results - and that shed light upon the questions in the paper). Also avoid over-extending the implications of what you have found. A slight trend in the results from your particular experiment may not be an entirely sound basis from which to challenge the fundamental tenets of evolutionary biology. (On the other hand it just could be; the skill is in spotting the few occasions when it is!).

Overall, keep the focus of the discussion firmly on the results, don't wander off into 10 pages of philosophical discourse on the state of the field in general. And keep the volume and depth of the discussion in proportion to the rest of the paper, and to the significance (biological rather than statistical) of the results.

2.7 Acknowledgements

This is the place to acknowledge persons or organizations who have made significant contributions to the execution of the work. For example: funding bodies, people who have contributed ideas or assisted with some of the actual work, landowners giving access to sites, specialists who have made identifications and people who have read and commented on the manuscript.
Don't get carried away. You may not really need to thank all your friends, relations and loved ones for general help through life's little crises.

2.8 Literature cited / References

In this section you should provide a complete listing of all, and only, references cited in the text of the report. There are three things to consider here -

- What to cite
- How to cite it in the text
- How to construct a reference list

2.8.1 What to cite

You should cite appropriate references wherever you make a point of substance (fact, or opinion) that is not your own or may not be regarded as common knowledge. e.g.

> Several species in the genus *Calopteryx* perform a complex 'wing floating' display as part of the courtship behaviour (Malmquist 1956) [Fact]
>
> This behaviour is generally considered to be a display of male quality (Fredenholm 1978, Agassiz and Moore 1980, Summers 1991). [Opinion of others]
>
> The function of this behaviour may be to signal the flow rate, and hence quality of a patch, to a female. [Opinion or proposal from this study]
>
> Damselflies are predatory both in the larval and adult stages. [Common knowledge]

2.8.2 Styles of citation.

If writing a manuscript for publication in a scientific journal, obviously use the style of the journal in question (exactly - including punctuation). If you are writing any other type of report, you can choose your own style, but if in doubt the easiest approach is probably to follow the style of a major journal in the appropriate subject area. There are two main styles you will encounter:

The most common (and most straightforward) cites references in the text using names and dates, and lists all references alphabetically in the reference list.

In the text, e.g.

> Wide fluctuations in temperature reduce egg viability (Smith 1987).
>
> or... Smith (1987) found that wide variations in temperature reduced egg viability.

In list -

> Smith, A. J. (1987) The effect of temperature on egg development and survival in the damselfly *Calopteryx virgo*. J. Zool. (Lond.) 47: 231-243.

Note that the necessary information about the journal is the journal title, the volume number (47) and the pages of the article (231-243). Journals often also have a part number, e.g. volume 47(2). In general you do not need this in the citation, the page numbers should be sufficient.

The list should be in alphabetical order by first author. If there is more than one reference by the same author then order them by date. If there are papers with the same first author but different second/third authors then these come after the single author papers by the first author, and in alphabetical order by second.. third etc.. authors, e.g.

```
Smith A J (1987) ....
Smith A J (1989) ....
Smith A J, Girton S and Mackay R H (1984) ....
Smith A J and Wallis K C (1983) ....
Smith A J and Wallis K C (1985) ....
```

If you have several citations by the same author in the same year in your list, then denote them with letters e.g.

In the text: `Smith (1987a), Smith (1987b)`

In the list:

> Smith, A. J. (1987a) The effect of temperature on egg development and survival in the damselfly *Calopteryx virgo*. J. Zool. (Lond.) 47: 231-243.
>
> Smith, A. J. (1987b) The oviposition behaviour of *Calopteryx virgo* (Odonata: Zygoptera). Anim. Behav. 27: 197-209

The other main style is to use numerical superscripts (or equivalent) in the text, numbering the references in the order in which they are mentioned in the text, and ordering the final reference list in the same way, e.g.

In the text:

> Wide fluctuations in temperature reduce egg viability[23].
>
> Smith[23] found that wide variations in temperature reduced egg viability.

In the reference list:

> 22. Wilcove H (1978) Mating strategies in a calopterygid damselfly. Anim. Behav. 16: 21-30
> 23. Smith A J (1987) The effect of temperature on egg development and survival in the damselfly *Calopteryx virgo*. J. Zool. (Lond.) 47: 231-243
> 24. Morris L L (1991) A model of territory switching behaviour. Am. Nat. 230: 390-395

In many journals using this system, the titles of the references in the list are also omitted e.g.

> 23. Smith A J (1987) J. Zool. (Lond.) 47: 231-243.

This is done to save space, but unless you are specifically asked to do this it is best to include the complete reference. Although such numerical systems usually require the reference list to be ordered by number, it is possible (and much more convenient) to use an alphabetical listing even if numbers are used in the text (alphabetically ordered references are numbered in order and then the numbers used in the text instead of names). The advantage to a numbering system is that is saves space in the text, the disadvantage is that the numbers don't tell you which paper is being referred to as you read - you need to keep looking them up in the list.

Some final points to bear in mind about references and their citation:

- Every reference cited in the text must appear in the reference list, and every reference in the list must appear in the text.

- Don't cite things you have not read or seen the relevant part of. If you need to cite something you have seen discussed or cited somewhere else, but haven't seen, and cannot get hold of, you should make it clear that you are citing someone else's interpretation of the original reference, e.g.

  In the text: `Jones (1928 - cited in Smith 1987)`

  In the list you should then give the citation for Smith (1987) not for Jones (1928).

- There are standard abbreviations for journal names. These are often given in the journal itself, and are available on a list in the Library, or can be found by looking up the journal on Biological Abstracts. If you don't know what the standard abbreviation is, and it is not obvious, them use the full name rather than making up your own abbreviation.

2.9 Appendices

Use appendices (if you must) for large amounts of raw data, long species lists, detailed mathematical or laboratory working, of a non-standard method, or (short) program listings, but only where the inclusion of such information markedly enhances the usefulness of the paper. Normally such appendices are not required - avoid using them just because you want to show how much data you collected!

3. Approaches to writing

Everyone will actually tackle the task of writing a report in different ways, dictated by a combination of personal preference and practical constraints. However, it is worth making some general suggestions, for use, or not, as seems appropriate.

You must expect to go through several drafts of a report before it is satisfactory. It is rare to get everything right first time. Word processors greatly ease the task of revising manuscripts and so it is generally better to get a draft down and then work on it on paper, rather than agonising too long in front of the screen in the hope of creating a literary masterpiece first time. It is much easier to get an overview of the structure, and to spot errors, from printed copy rather than trying to do it entirely on the computer, where you are always peering at a fragment of the manuscript though a little window. Some people write directly onto the word processor, others draft something out in longhand (remember that?) before starting to type. If you compose directly onto the computer then you should have a clear written plan of what you want to say before you start, otherwise you will waste a good deal of computer time.

It is generally suggested that starting with the Results and/or Methods sections is the easiest approach - these require straightforward reporting of factual information, and by the time you get onto the Discussion and Introduction the pattern and presentation of results will be clearly established.

Keep your writing simple, clear and concise. Science writing is about clear communication, not verbal acrobatics. Try to explain things to an appropriate level for the intended audience. Bear in mind that you are likely to have spent a good deal of time working on, and thinking about, the problem you are discussing, and that things which may seem obvious to you may not be so obvious to your reader.

When you have what you consider to be a passable draft of the report then get a couple of other people to read it critically for you (and be prepared to accept their honest comments!). It is of value to have the manuscript read by people who know the field and those who don't; they will pick up different things.

Run a spellchecker on the document - but don't automatically accept the spelling corrections it suggests. If you are not sure, use a dictionary.

If possible, it is worth putting the report away somewhere for a couple of weeks and doing something else, then going back and rereading it. You will find that you can see a report's faults much more readily after a break from working on it.

4. Afterword

No discussion can cover all the subtly different sorts of report that you may be required to write at one time or another, but the ideas above provide a guide to one of the commonest. It is only a guide, and some circumstances will require a different approach, or structure. One way to develop your scientific writing is to think critically about the papers you read, not just in terms of the science they present, but also the effectiveness of that presentation. Decide what works well and what doesn't, then adopt the good ideas.

Further reading

Barnard C, Gilbert F & McGregor P (1993) *Asking questions in biology*. Longman.
Booth V (1985) *Communicating in science: writing and speaking*. Cambridge Univ. Press.
Lindsay D (1990) *Scientific writing*. Longman

NB - The example study used here is fictitious (though based on fact), as are the references used as examples (the journals are genuine). If the topic of the example study is of interest to you then the place to look is:

> Gibbons DW & Pain D (1992) The influence of river flow rate on the breeding behaviour of *Calopteryx* damselflies. *J. Anim. Ecol*. 61: 283-289