Notes on protocols, bachelor or master theses & publications

First version by Christian Körner, Uni Basel (June 2005), modified and extended several times by Gerhard Zotz, IBU, Uni Oldenburg, last version July 2023

Scientific communication follows special rules that aim to communicate findings and facts clearly, briefly, concisely and in an argumentative style. Certain outline rules and information sequences have proven to be practical and have become established. Compiled here is an annotated overview that concerns all students who want to write reports on internships, on a project work, theses or even manuscripts for "real" publications. The length specifications given should be understood as rough, non-binding guidelines.

Report language: Simply put: report language is past tense ("the maximum size of the examined leeches **was** 12 cm"), but general statements and facts are expressed in the present tense ("there **are** about 350000 described beetle species"). But there are many borderline cases - a detailed discussion can be found at: https://services.unimelb.edu.au/__data/assets/pdf_file/0009/471294/Using_tenses_in_scientific_writing_Update_051112.pdf.

Scheme of the 1st page

A possible cover sheet for the report on an internship attempt is presented below. For theses, the division specified in the respective examination regulations applies in principle. For manuscripts, see the instructions of the respective journal.

Work title

Author

Laboratory Methods in Functional Ecology Lab Course
Winter semester 2023 / 24

Supervisor:

Summary : (*example)*

The photosynthetic performance of a plant is highly dependent on the water factor. Shallow-rooted plants should be more frequently affected by varying water availability than deep-rooted plants and therefore be more sensitive to differences in water status. We investigated this hypothesis in 10 species that ...

General information about the formatting of the text

- Readability is increased if spacing of at least 1.5 lines is selected. Be sure to number pages. Font type is ultimately a matter of taste, Arial or Times New Roman are often used, usual font sizes are 10-12 pt. No footnotes in scientific texts. Emphasize headings (e.g. with bold print).
- Numbering of sections is a matter of taste.
- All taxonomic names such as genera and below (e.g. subgenus, species, subspecies, or variety) are written in *italics.*
- Opinions differ about flat and justified typesetting. Justified type gives a "clean" look. Disadvantages are, however, that without activation of the hyphenation help, large holes often appear in the text; with activation of the hyphenation help, undesirable hyphenation or hyphenation that no longer fits when pagination is changed occurs. In addition, hyphens are often confused with dashes. Ultimately, however, the choice is a matter of taste.
- Numbers in the text are usually written out up to 10 if they are not related to units (i.e. "nine repetitions" but "7 cm"), above 10 always with digits.

Title of the written document

The shorter and more meaningful the better. Use meaningful words if possible and avoid meaningless expressions such as "the effect of" or "the influence on" or "studies about".

Summary

This comprises about half a page (15-20 lines), with the most important aspects and findings arranged in the same order and structure as in the overall work. The summary is thus a mirror of the whole work, and it must be coherent, i.e. it does not report THAT something was done/discussed, etc., but it says WHAT was found and discusses it in the context of what is known. After reading the abstract, a reader knows topic and main findings without having read the rest of the paper, how the data came out, and what it means for the research field. The results can usually be formulated in a way that IMPLICITLY communicates the methodological approach in the process.

Note: You have probably already read some summaries of publications and noticed that it is not at all easy to create a good and coherent summary.

Introduction (For a project 1-2 pages)

The scientific question is described. Based on what is known and with reference to publications, the reader is motivated to continue reading. The review of relevant publications is an essential part of the introduction of the topic. There are many tools available for this, e.g. databases such as Web of Knowledge or Google Scholar. The argumentation, supported by references, must make clear why this question should be answered and what the goal of the presented work is. The introduction culminates in a scenario, i.e. an expectation (hypothesis) is formulated and justified. For the reader it is obvious what should be answered in the end.

Note: mere curiosity and *"wanting to know"* are legitimate motives in themselves, but they usually lead to diffuse observational activity. This can be the starting point of working hypotheses (if one knows nothing at all and only pursues hunches), but more is expected for a publication or a project. Mere *"not knowing"* is a very poor motive. Papers that start by stating *"it would be interesting to know...."* or *"too little is known so far, so I would like to find out more..."* are seen as rather weak (because this justifies almost anything). A scientifically attractive justification is based on a theory that allows us to plausibly derive expectations. The introduction is often the most difficult part of the text and usually gains with the experience of the writer. Ideally, the hypothesis/-es should already be established at the beginning of the practical research work(s) and only be formulated here. However, this is often rather diffuse and integrating the central ideas into a sound, logically structured introduction is often easier if written <u>at the end of</u> the writing process.

Methods (1-2 pages)
Here, the data collection is explained briefly and succinctly. Nothing essential must be assumed. The principles of key methods must be described at least briefly, one cannot refer the reader to the literature, although details may be found there. A reader must be able to evaluate and repeat the observations or experiments with this description without additional information. For field observations, this includes information on location and time. It is best to put yourself in the role of the reader. Above all, the observation and experimental design as well as the sampling strategy (replication, etc.) must be presented without ambiguity. Equipment, tools, etc. must be specified: Type, manufacturing company (not the distributor!), location of the company (place), country.

Finally, it has to be explained how the data were handled (e.g., which statistical procedures (and why they were used) and which program was used).

Results (for project work: pure text 3-8 pages, figures and tables are integrated into the text)
The results must be clearly addressed with a reference to the corresponding figures (e.g. Fig. 1) or tables (e.g. Tab. 3). It is not sufficient to simply present graphs and tables and leave it to the reader to make sense of them. Sentences like *"The results of the litter trap analyses are shown in Fig. 1"* are superfluous. A better alternative would be *"In the leaf litter, beech clearly dominates with 70 %, followed by maple and oak (Fig. 1)"*. After all, it is clear from the context that we are talking about "results", that we are talking about "analyses" and that we are talking about "litter traps" as in this example. <u>Always formulate a statement and not an intention</u>. Inappropriate are mere descriptions of diagrams or the repetition of figures from tables in the text. There, you summarize, use percentages when comparing numerical values, for example, and address the major patterns or point out special features. Statistical information is not an accessory, but an integral part of the presentation of results. So do not state "*x decreases with increasing y"* and continue with "*the correlation is not significant"!* Instead : "There is no significant correlation of x and y (Stat test, p-value)". Statistical information can also be given in figures, figure legends or tables.

The results should be addressed in a coherent and accentuated manner (not just neutrally lining up one finding after the other). Comparisons are best made with an evaluative undertone, which may also reveal astonishment, importance, agreement or contradiction. It is also important to present the results in a logical order. It is often helpful to communicate this logic to the reader, for example by stating in the first sentence of the results according to which concept the results will be presented. To make this logic more visible, subtitles are helpful in longer texts.

Discussion (for project work: 3-5 pages).
As a starting point for the discussion, it is best to make an interpretive summary of the most important results: *"My research shows that...." or, "The essential result of the work* is.... Then follows (if not already implied) an evaluation of the results in the light of the hypothesis (falsified/non-falsified). After that one comments on the results

(1) by comparing within your own data sets and uncovering relationships between your own data,

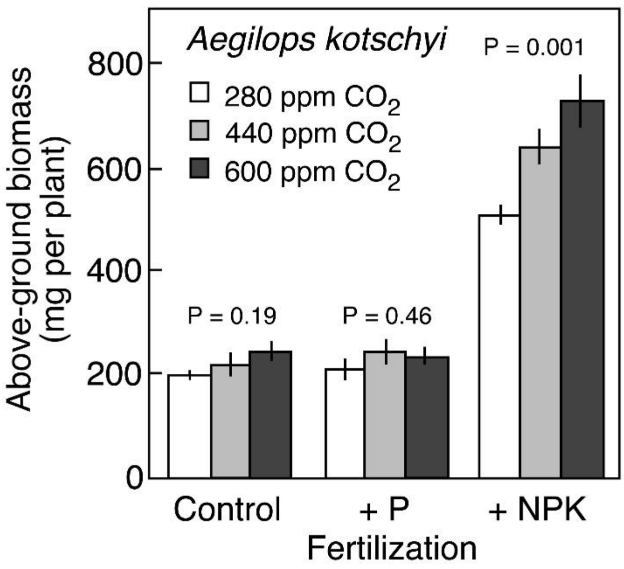
(2) by comparison with the literature, i.e. what other researchers found,
(3) through a discussion of the consequences, i.e. the integration of the new findings into the existing knowledge: how does our theory building on the subject change? Where have we become wiser? What does it refute or confirm? What should be the next steps?

Conclusions (approx. 1/2 page)
Often, this final section is placed at the end of the discussion without an intermediate title as a paragraph. With its own title, however, the conclusions are more prominent. In any case, the practiced reader looks for the "quintessence" here in the last lines of the paper. Here the results are not repeated, nor is a second summary (abstract) written. Here the significance of the findings for the field of science and its practical consequences are pointed out, in short, the reader is given the "take home message". "Forbidden" conclusions are *"I can't conclude anything because I have too little or too inaccurate data"* (this is a popular evasion, but one can always conclude something positive!) or *"that more research is needed"* (a truism that is not very helpful). This section is difficult part of science, because far-reaching conclusions usually require a profound knowledge of the subject. For beginners, it is undoubtedly the biggest hurdle because the conclusion must go beyond one's own data. NB: It is pointless to put the facts themselves as a conclusion.

Figures, tables and equations

1. illustrations
Illustrations must be self-explanatory, i.e. understandable without the main text. Together with the information in the legend, the reader must be able to understand them. Therefore, no cryptic symbols or abbreviations should be used. Figures do not have a title, but **below the figure** there is a legend of several lines, which begins with the note "Fig. 1" or similar. The first sentence of the figure legend addresses the topic, e.g., *"The annual amount of litter in a mixed deciduous forest near Oldenburg."* This is followed by any necessary explanations and statistical data.

- "Minimum ink" - the simplest form of representation should be chosen. Three-dimensional representations are almost always unnecessary and obscure more than they illuminate.
- The axes should be labelled with full text parallel to the axis (no abbreviations if possible).
- At the end of an axis text, the unit is written in round brackets ().
- Specify units in power notation without fraction bars, i.e. gm^{-2} not g/m^2
- The scaling should be decadal
- The scale should start at zero. However, if there are certain reasons not to do so, this should be justified in the legend.
- The scale must not be different between figures for the same data (loss of direct visual comparability). If large differences between measured values make scale adjustments necessary, this must be mentioned (e.g. English: "note the different scale"). Here there is also the possibility of axis interruption.



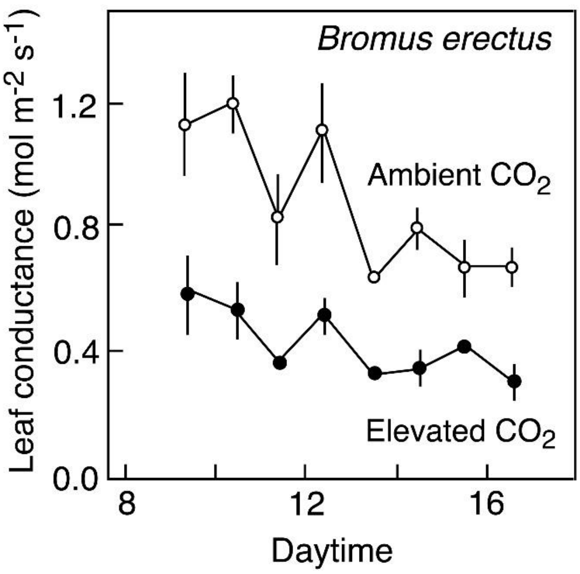


Fig. 1: The influence of elevated CO_2 on biomass production under two different nutrient regimes (P for CO_2 effect, n=4 per treatment combination, data are means ± s.e.).

Fig. 2: Leaf conductance in the dominant grass species of calcareous grassland under two CO_2 regimes (n varies from 2 to 8; at elevated CO_2 some of the error bars are smaller than the symbol).

Programs like Excel place another frame around a finished diagram, which international scientific journals reject (waste of space). In a graph, one always leads the reader from left to right, i.e. in the case of block diagrams where there are any reference values, initial states or control values, these are usually on the left and any treatment effects or other changes follow on the right. Experienced readers will expect "unfilled", bright signatures (e.g. white bars) for control/reference values and dark ones for treatment effects. The "light" is always the usual, the "dark" the special. Logically, however, there can also be e.g. a light bar for day values and a dark one for night values. Consistency is important: If parameters appear several times in different diagrams, the same symbols and fillings should be used. For error bars it must be explicitly stated whether they are standard error or standard deviation with number of replicates (n=....). **Please do not use bar charts in which mean values are shown without error bars or other statistical information.**

Fonts: do not choose ornamental fonts. "Helvetica" is particularly suitable for diagrams. Do not use more than two font sizes in an illustration. Do not letter too small (figures are typically reduced in size in print).

2. Tables

In contrast to figures, the accompanying text is placed **<u>above</u>** the table (table header) and should normally not exceed three lines.

It corresponds to the legend for the figures, but is limited to global issues, while further details can be placed as a footnote at the bottom of the table. Each table starts with a bold, horizontal line (below the table header) and ends again with a bold, horizontal line, below which a footnote can be placed at most. Within the table there are no vertical lines, but only (and as far as necessary) horizontal, thin lines for rough structuring. In any case, a horizontal line must be placed between the column headings and the data. Further horizontal lines are to be avoided as a rule. Decimal numbers are set so that the decimal points are exactly below each other. **An <u>unrealistic number of digits</u> (decimals) cast a bad light on the author's sense of reality, not only in tables.** In ecology, for example, there are rarely measurements with an accuracy greater than 1%. Therefore, anything that exceeds a total of three significant digits is problematic, regardless of whether they are before or after the decimal point (pseudo-accuracy). In tables a measure of variance (e.g., the standard error) should also be placed next to the mean values (and named as such in the table header), and in the case of comparative data, it should also be indicated in an additional column whether the values differ significantly.

Example of a table:

Table 1: Important characteristics of species 1 and 2. Values are means ± standard deviation of 5 individuals per species.

Parameter	Species1	Species 2
Height	105 ± 12	92 ± 12
Width	111 ± 10	100 ± 9
Length	122 ±	989 ± 14
Density	101 ±	1199 ± 2

Statistical data

For statements on significance, the general rule is to indicate 1) the statistical test used, 2) the specific p-values, possibly also <p-statements. In complicated tabular presentations, marking individual columns/rows with asterisks can be useful ($p < 0.05$ *, $p < 0.01$ **, $p < 0.001$ ***). In the case of non-significant differences, the p-value is also interesting for the reader, because it makes a difference whether the p-value is 0.9 or 0.055. However, it should be rejected to derive a "marginal significance" from the result of an analysis with a p-value of 0.05 - 0.1 in the text, as one can occasionally read. **Please always keep in mind: Statistical significance must not be equated with biological relevance!**

3. equations

Equations are centered in a separate line with equation number (referred to in the text). All variables are explained in the text.

Example:

Als Maß für die Nierenfunktion wurde die Clearance C aus der Urin-Konzentration K_{Urin} und Plasma-Konzentration K_{Plasma} von Kreatinin, sowie dem Urinzeitvolumen $\dot{V}$ bestimmt:

$$C = \frac{K_{Urin} \times \dot{V}}{K_{Plasma}} \qquad \text{(Gleichung 2.1)}$$

Literature citations

Working with citations is difficult! Citations serve to substantiate statements or to acknowledge the work of others and not to pretend that one has found something new oneself. Unmarked literal copies of text passages are a form of scientific misconduct and are plagiarism. But even below this threshold, many mistakes can be made. As a frequent case, papers are cited that did not even investigate the fact to be proven themselves, but in turn cited other papers. In such a case, it would be more correct to refer to the original work that first established this fact, to major *review* articles, or to textbooks in which the previous knowledge was summarized. It is equally inappropriate to always cite only the most recent work for observations that have been known for a long time.

All citations mentioned in the text must appear in the bibliography and vice versa. In the running text, literature citations can be inserted as follows: *"...as Huber (1991) found."* or *"...as found in several other studies (Huber 1991, Meier et al. 2001)".* However, it is more crisp to link a statement to the citation: *There are about 18000 known bird species (Aves & Orni 2015).* But beware: lavish lists of citations placed in parentheses at the end of a statement often have the sole purpose of suggesting to the reader: *"I have read quite a bit"*. It is much better to address really relevant studies from their content in the text, so that the reader gets an idea of why there is a reference to this work (qualified citation). As an example, a statement like *"as Huber (1978) also found"* is of less value than the statement *"Huber (1978) found 20% larger chlorophyll grains after plants were exposed to elevated CO_2, which is about the same as the difference found here."*

Formal: Two authors are named with "and" or "&", more than two authors are abbreviated with *"et al."* (from Latin *et alii* = and others). In the bibliography itself, citations must be made with all important bibliographic information. Different journals require different formats from their authors. We recommend the following citation format, the first example being for an original journal article, the second for a book, and the third for a book chapter. These are the three main categories. However, ultimately format is a question of taste. The journal abbreviations follow an international code. The list usually includes all authors, even if there are sometimes many. In the format of the titles, please ensure consistency, i.e. do not mix "title style" ("Alpine Plants are Green") with "sentence style" ("Alpine plants are green").

Examples

Sukumaran J and Knowles LL (2017) Multispecies coalescent delimits structure, not species. PNAS 114: 1607 - 1612

Pierce BA (2016) Genetics: A conceptual approach plant life. Freeman, New York

Körner C (1999) Alpine plants: stressed or adapted? In: Press MC, Scholes JD, Barker MG (eds) Physiological plant ecology. British Ecol Soc and Blackwell Science, Oxford, pp 297-311.

Note: Umlauts (ä,ö,ü) should not be set as "ae", "oe", "ue". Accents should be put ("végétation" in a French paper not "vegetation"). When publishers "sit" in more than one place, only the first seat is mentioned. Words such as "publisher," "publishing house," "Ltd.", "Corp." are omitted.

Appendix (not mandatory)
Additional materials, methods and results can be compiled in the appendix. Today, it is becoming more and more common to publish raw data and detailed descriptions of the methods, extended literature lists, etc. in an appendix (sometimes also only electronically) with the actual paper and thus make them available for meta-analyses, for example.

Further remarks on scientific writing

(1) Abbreviations must be explained when they are first mentioned. This is usually done implicitly: "the measurement of photosynthetically active radiation (PAR) is performed with... ". From this point on, PAR can be used without further explanation in the text.

(2) Be sparing with paragraphs. The purpose of dividing a text into paragraphs is to make related sections visually recognizable (coherent information packages). You can also separate paragraphs by a free line and not only by a forced new line. It is not uncommon for the end of the preceding line to fall near the right-hand end of the sentence, which means that the goal of making a paragraph visually distinct is not achieved.

(3) Inclusion of figures and tables. Unlike <u>protocols</u> and <u>theses,</u> manuscripts for journals do not include figures and tables in the text. These must be typically included after the text on separate pages. This also applies to the legends to the figures, but not to the table headers. The electronic documents to be supplied must also be structured in this way. Figures and tables must be numbered from 1 to n and must be addressed as such in the text (even if only *one* figure or table exists). This also applies to an appendix = annex. Thus, there must be no figures or tables that are not addressed in the text. This reference (e.g. Fig. 1) is often placed in brackets at the end of a statement (end of sentence). If this is followed by several sentences that refer to the same figure, this "jump command" is NOT repeated each time.

(4) Avoid repetition. It is not possible to completely avoid repeating a fact in a paper, but it is important to do this sparingly. It is unnecessary to “regurgitate” the same sentence in the abstract, in the results, in the discussion, and in the conclusions. Likewise, elements of the introduction should not be "cooked up" in the discussion.

(5) Writing style: short and concise sentences, especially in English! Typical German nested sentences are often not translatable into English and lead to confusion even in German. German syntax is often difficult to understand for foreign speakers. A typical example: in German it is common to use "this" to refer to the object or fact of the last subordinate clause. In English, this is usually not understood.

(6) As you write, remember that you are dealing with what is often the most difficult chapter in science: passing on information logically and persuasively, and getting to the heart of often complicated issues. You are not alone with this problem; everyone struggles with it, especially in the beginning. **A logical concept of thought is a prerequisite for logical information flow.** That's why it's often useful to make an outline before you start writing, in which you make the logic of the report clear to yourself. Highly confusing is an alternating sequence, e.g. the description of the facts in the order ABC in the introduction, the representation as CBA in the result part, followed by the discussion of CAB. Should your investigation include e.g. two treatments, it is very important that you consistently always address them in the same order (effect A, effect B and, if necessary, interactive effect of A and B). This logic should not be broken. In school, we are trained to use different words for the same thing to make a text more “interesting”. In science, unclear synonyms only lead to confusion, if new terms are used for the same thing! Therefore, do not be afraid to stereotypically use the same vocabulary over and over again. **A term is a term is a term!**

(7) In the past, it was common to write scientific texts in the third person or in passive voice. This has changed. In multi-author publications, it is now common to speak of "we"; in single-author work "I" is also quite "respectable". In your project report, therefore, do not get uptight with "one could recognize..." or "it was observed...".

Something else important for all those who are writing a **Bachelor thesis** in Oldenburg. It is possible to write in German or English. In case of a thesis in English, an abstract in German <u>must be</u> included, but also in the opposite case an abstract (in English) is desirable.