

PART 2:

Writing a scientific article

Why to publish?

- **This is your job!**
- You are spending PUBLIC money
- Making research without communicating its results to the public doesn't make sense!
- Scientific progress is impossible without extensive exchange of information and ideas
- Working on a publication helps in gathering thoughts and clarifying ideas
- „Publish or perish” imperative – a pitfall?
- **IT GIVES JOY AND SATISFACTION!**



Let's start writing!

- Scientific writing is a technique rather than art → you **HAVE** to learn it and you **CAN** do it
- Crucial ingredients of a scientific paper:
 - thought – results – message
 - structure: proper and simple order of presenting things
 - style: brief and to the point; good grammar
- Planning the manuscript
 - use your **BRAIN** rather than 'cut and paste' approach!
 - prepare and interpret your data
 - decide on authorship

Authorship: the Vancouver Protocol

- Each and every author of a publication needs to have been involved in the:
 1. Conception and design, OR analysis and interpretation of data

AND

 2. Drafting the article or revising it critically for important intellectual content

AND

 3. Final approval of the version to be published.
- ➔ Each and every author, without the help from co-authors, should be able to understand, to present and to defend the general ideas and findings published in the paper.

Authorship: YES or NO?

	NO: Non-scientific contribution
	Obtaining funds for the research
	Supervision of a research group
	Running an experiment, technical support
	Involvement in the collection of data
	Running models with only slight (if any) modifications to existing models
	Statistical analysis according to instructions
	Proof-reading, commenting on the paper
	Literature search
	Providing data or important materials (but...)

Authorship: order

- Vancouver Protocol: ‘the order of the authorship on the byline should be a joint decision of the co-authors. Authors should be prepared to explain the order in which authors are listed’.
- Equal contribution: alphabetically or ‘rotation’ (if more than one paper)
- First author vs. corresponding author
- Student-supervisor manuscripts
- The problem of ‘honorary authorships’ and ‘gift authorships’
- Acknowledgments: a written permission from all!

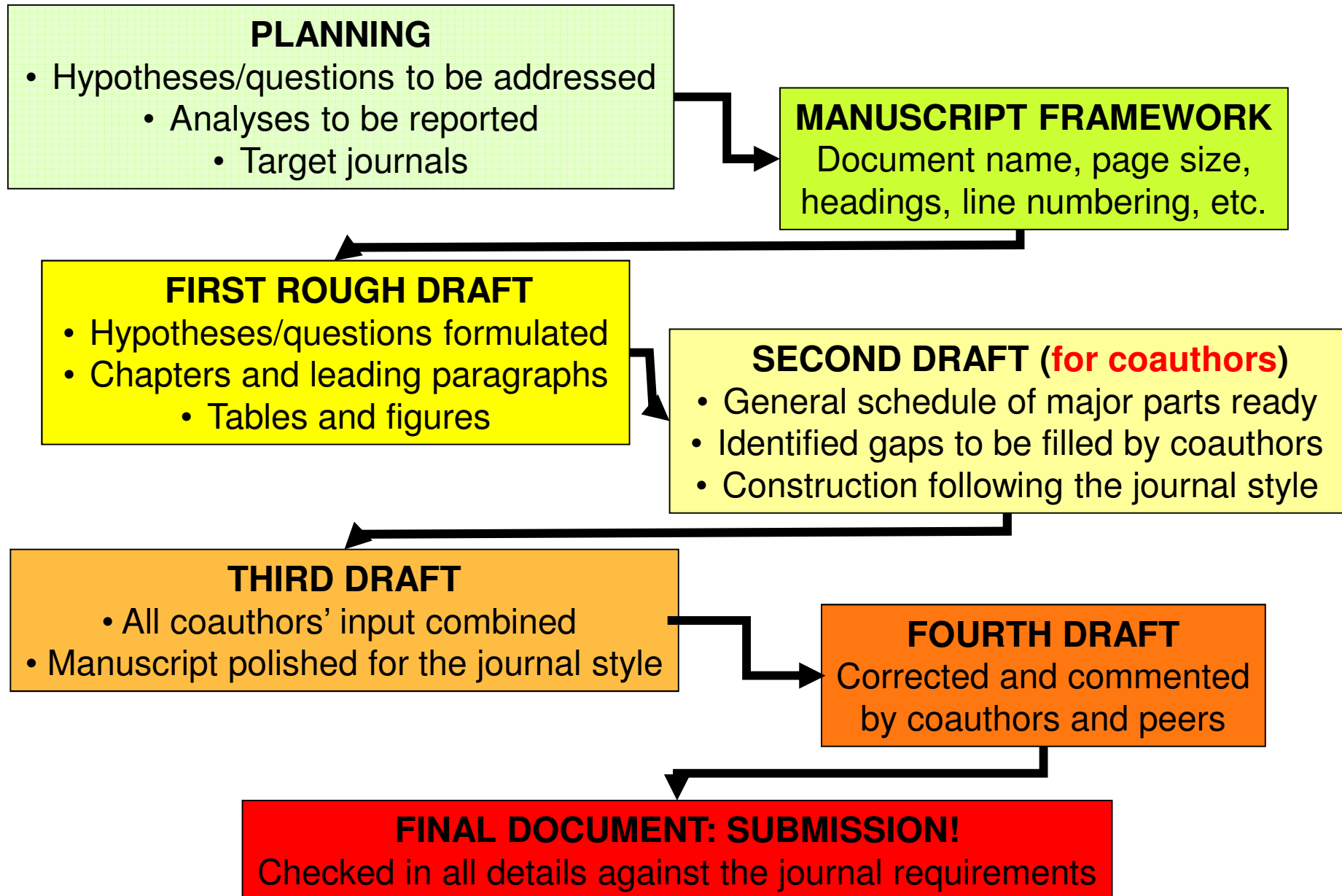
Authorship: first author - coauthors

- First author
 - Primary responsibility
 - Conducts/supervises data analysis
 - Interprets results
 - Writes the paper (with coauthors)
 - Ownership of the master documents
 - Submits the paper to a journal
 - Archives all data
- Coauthors
 - Participate in decision about the aims of the paper
 - Contribute intellectually to data analysis
 - Contribute intellectually to interpretation of the results
 - Review each draft
 - Keep the paper on track of the main messages
 - Take responsibility for the content and results

Acknowledgements

- “*By all means recognise secretaries, wives or husbands, lovers and parents – **but not in the manuscript***” (A. A. Spence. 1994. Discussions. In G. M. Hall (ed.): How to write a paper: 30–32)
- **Who and what should be acknowledged:**
 - General support by a department head or an institution
 - Technical help, laboratory work, and data collection
 - Input of students, trainees, and research assistants
 - Statistical, graphics, or library support
 - Critical review of the drafts
 - Financial support from granting bodies

The manuscript production line



Structure of the scientific article

- **IMRD:**
 - **I**ntroduction (1-2 pp)
brief and arresting
 - **M**ethods (1-2 pp)
VERY detail
 - **R**esults (1-2 pp)
to the point and clear
 - **D**iscussion (2-3 pp)
compare your results to
those by other researchers
- Additional parts of the manuscript:
 - abstract (100-200 words)
 - acknowledgements
 - references (max 30)
 - tables
 - figure captions
 - figures (max 6 tabs AND
figs)
 - (supplementary material)

Title of the paper

- Concise, to the point, informative, attractive
- Factually correct
- Consider the (real) examples:
 - *“Further studies on environmental factors which may affect the influence of some metals on selected soil dwelling and epigeal invertebrates”*
 - *“Temperature and soil moisture increase susceptibility of earthworms and carabids to zinc and copper”*

Which one do you think is better?

Abstract

- **The most important part of the manuscript**
 - too many papers to read them all – abstracts help in selecting the most relevant and important ones
 - much wider availability than the paper itself
- Whole article in 100 – 200 words
 - *Sentence 1*: aim of the study
 - *Sentences 2-3*: methods
 - *Sentences 4-5*: main results
 - *Sentence 6*: conclusions

Abstract: be brief!

*“Multi-generation exposure of organisms to toxicants may lead to adaptations increasing their resistance to a chemical. However, the increased tolerance may have a negative effect on fitness in uncontaminated environments due to increased maintenance costs in adapted individuals. Herein we present results of a multi-generation experiment on the flour beetle, *Tribolium confusum*, showing that animals bred for ca. 10–13 generations in copper-contaminated medium had higher maintenance costs than their counterparts originating from uncontaminated medium. The results show that significant changes in energy budgets may occur even after relatively short selection in small laboratory cultures.”*

Word count: 95

Introduction

- **2-3 pages:** do not bore readers to death!
- *Paragraph 1: what we know*
 - summary of the contemporary knowledge on the topic
 - the importance of the first two sentences
- *Paragraph 2: what we don't know*
 - identifying the gaps in knowledge
- *Paragraph 3: what we did and why*
 - the goal of your study and how you approached the problem
- **Do not:**
 - attempt to review all literature on the subject
 - refer to textbook knowledge
 - present a review of history of your research

Introduction: examples

- **Bad:**

- *“As early as 1837 and then again 1881, Darwin called attention to the important ecological role that earthworms play in many terrestrial ecosystems”* (in a paper on effects of heavy metals on earthworms)

- **Better:**

- *“Metal pollution may disturb soil ecosystems by affecting soil invertebrate populations”* (from a paper on Cd and Pb effects on earthworms)
- *“Earthworms can accumulate high metal burdens from contaminated substrates due to highly permeable body surface, the detritivorous feeding habit, and metal-sequestration mechanisms”* (from a paper on Cd, Cu, Pb and Ni effects on earthworms)

Methods

- Frequently: “*Materials and methods*”
- Very detailed (as long as necessary, as short as possible)
- Making it possible to repeat the experiment in every single step and detail
- Leaving no doubts about the exact methodology used, e.g.:
 - breeding animals (species, food, conditions...)
 - study design (including number of replicates, etc.)
 - specific methods (e.g., chemical analyses, measurements, etc. – equipment, make)
 - data analysis (methods, software)

Results

- The second most important part of the manuscript
- Put stress on the most important results
- Each sentence should bring a message (avoid 'empty' sentences)
- Present the data in relation to hypotheses tested
- Whenever possible, use clear, well described graphs to illustrate your results
- Do NOT mix with discussion (unless the journal uses the combined form of 'Results and discussion')

Results: examples

- **Bad start of the section:**

“Results of the chemical analyses are shown in Table 1, and differences between the groups are illustrated on Fig. 1”

- **Better:**

“Average Zn concentrations in soil were 87 ± 13 mg/kg at site A, and 465 ± 34 mg/kg at site B, while concentrations of other chemical elements were similar at both sites (Table 1). The respiration rate of soil microorganisms was significantly higher at site A ($p < 0.001$; Fig. 1). The sites did not differ, however, in microbial biomass ($p > 0.1$; Fig. 2).

→ **Message:** all sentences should be meaty

Results: scheme

- *Paragraph 1: what did you study*
“A total of 574 male beetles were used in the study. Before the start of the experiment, the treatment groups did not differ from each other in terms of body mass or respiration rates.”
- *Paragraph 2: what is the main result*
“The respiration rate decreased significantly with pesticide concentration ($p=0.02$) and increased with temperature ($p=0.003$) with no interaction between the factors (Fig. 1). After two weeks no effect on body mass was found ($p>0.6$; Fig. 2).”
- *Paragraph 3: what else came out from the study*
“As expected, respiration rate increased with body mass... „

Results: **do not**

- Do not make confusing statements
“There was a clear although not significant trend of decreasing respiration rate with increasing Zn concentration in soil”
- Do not over-interpret your data (relates also to Discussion)
- Do not extrapolate your models beyond the range actually studied
- Do not mix-up p value with importance or magnitude of effect: ‘highly significant’ (e.g., $p < 0.0001$) does not necessarily mean effect that is large or important for a population (but it can be!)

Results (and elsewhere): reporting numbers

- Single-digit numbers – use words (*five beetles*)
- Multi-digit numbers – use numbers (*26 beetles*)
- Never start a sentence with a number (*Twenty six beetles died during the experiment*)
- Put a space between a number and its unit (*58 km; 0.125 g*)
- No space between a number and % sign (*96%*)
- Do not report numbers with greater precision than actual measurements; one decimal place more for statistics (means, medians, SD, CI, etc.)

Results: tables

- Follow the journal style
- No grids, only few basic horizontal lines
- Sufficient space separating rows and columns
- Do not overload tables (better split into two)
- Place columns in a sensible order (left to right)
- Do not repeat the same information in tables and graphs

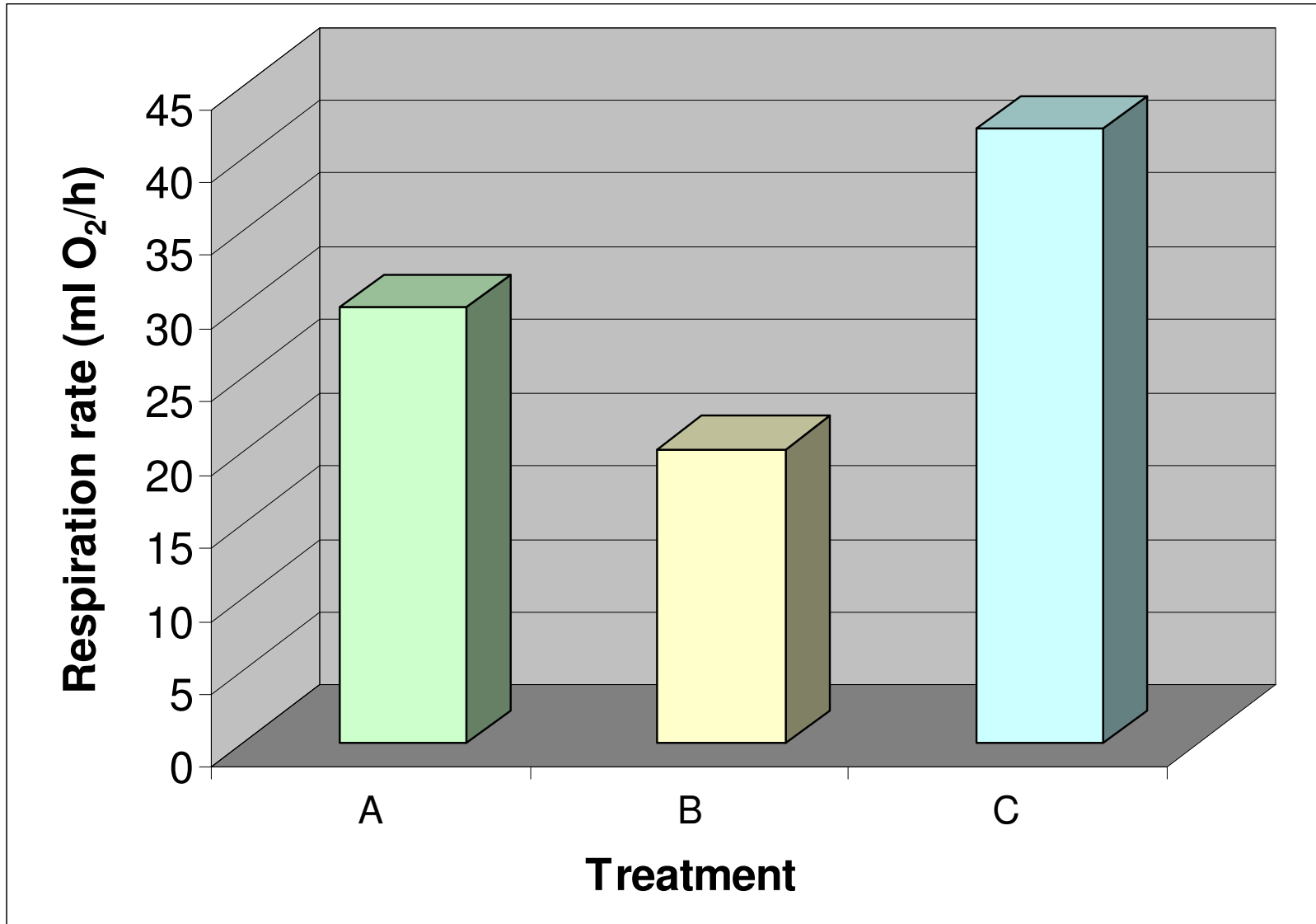
Results: tables and graphs

- Formatting tables

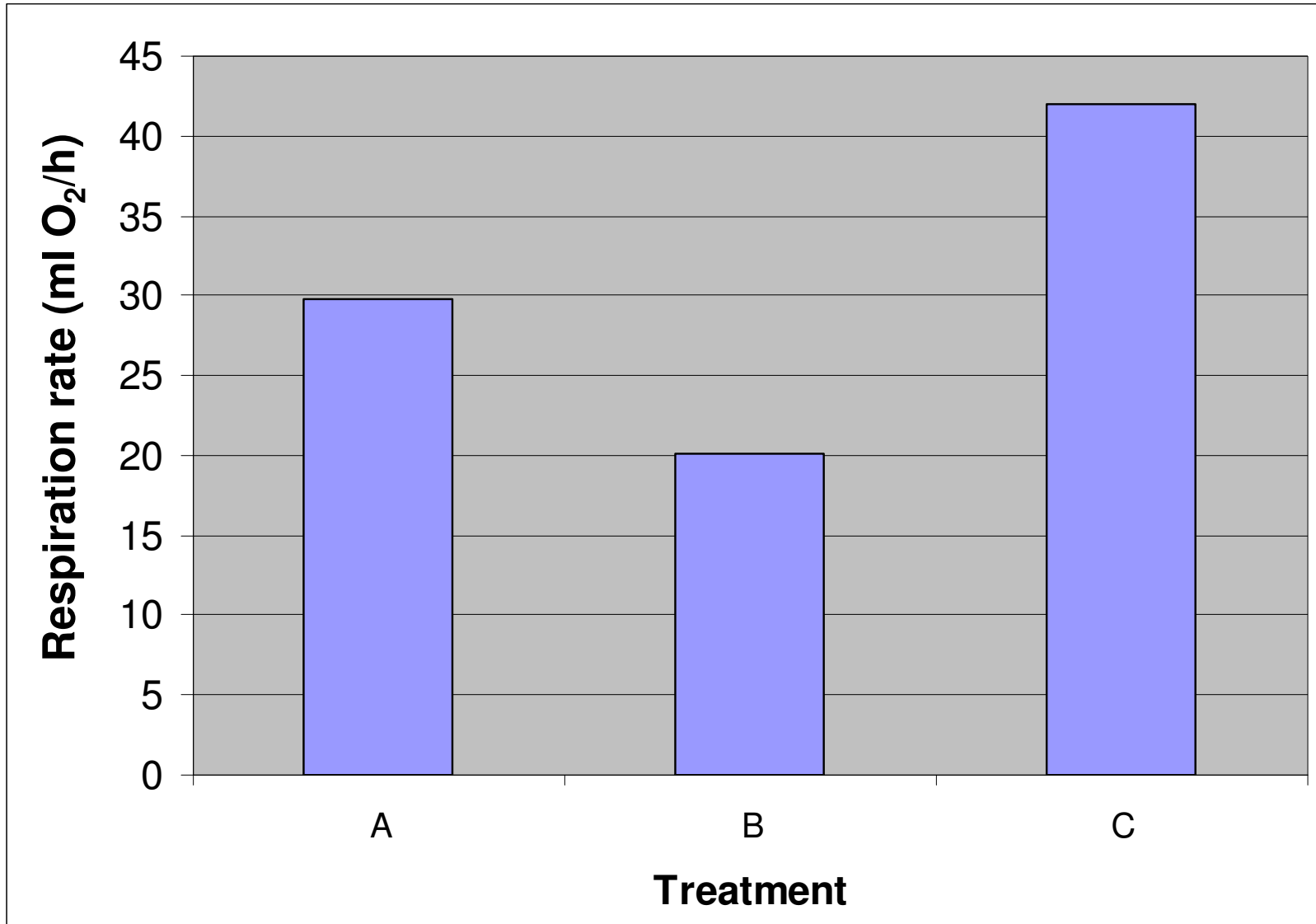
- *These data will be used to illustrate bad and good ways of presenting the data on figures*

Experimental groups		
A	B	C
23	12	38
25	14	40
27	16	42
29	18	44
31	20	46
33	22	48
35	24	50
37	26	52
39	28	54

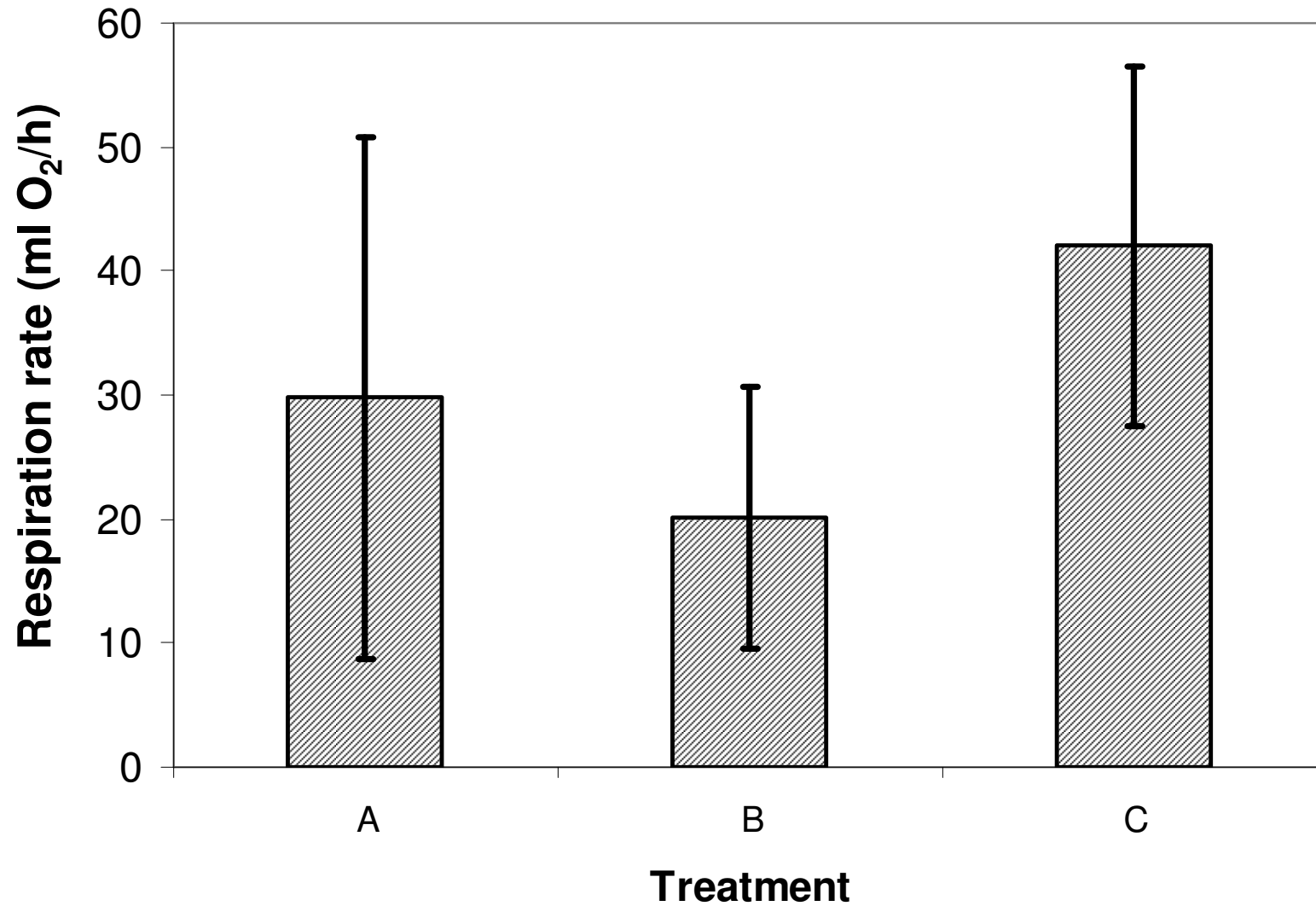
Results: graphs



Results: graphs

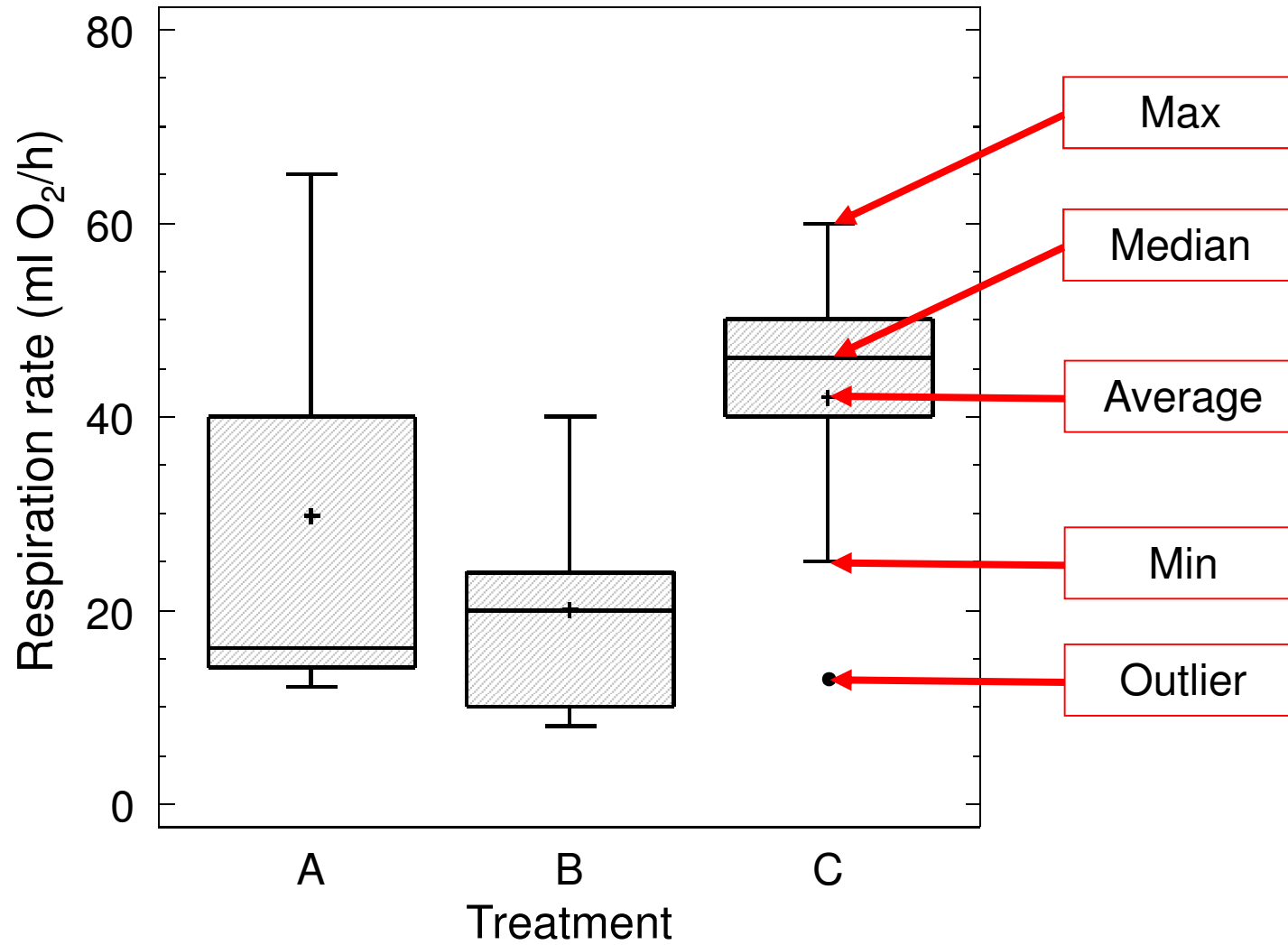


Results: graphs

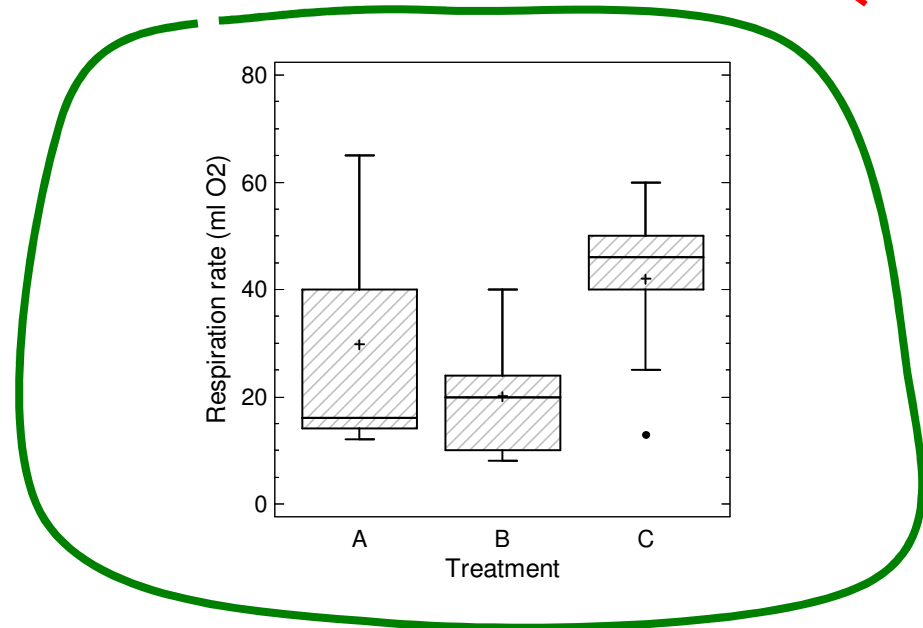
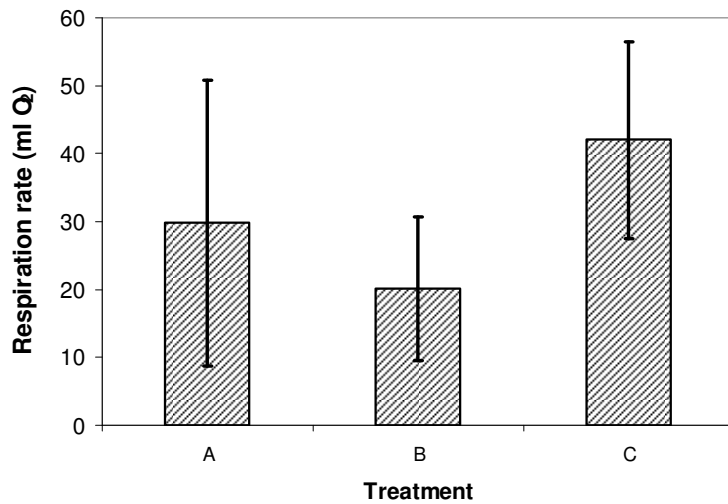
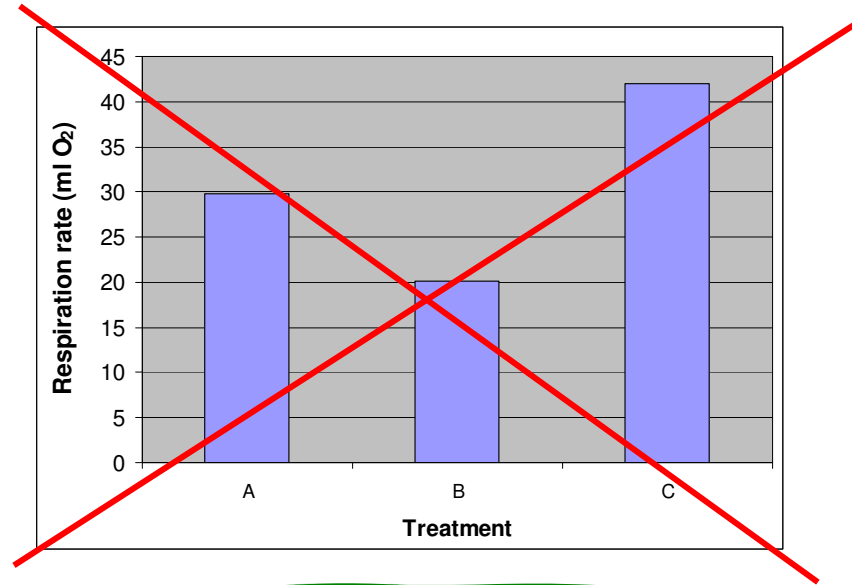
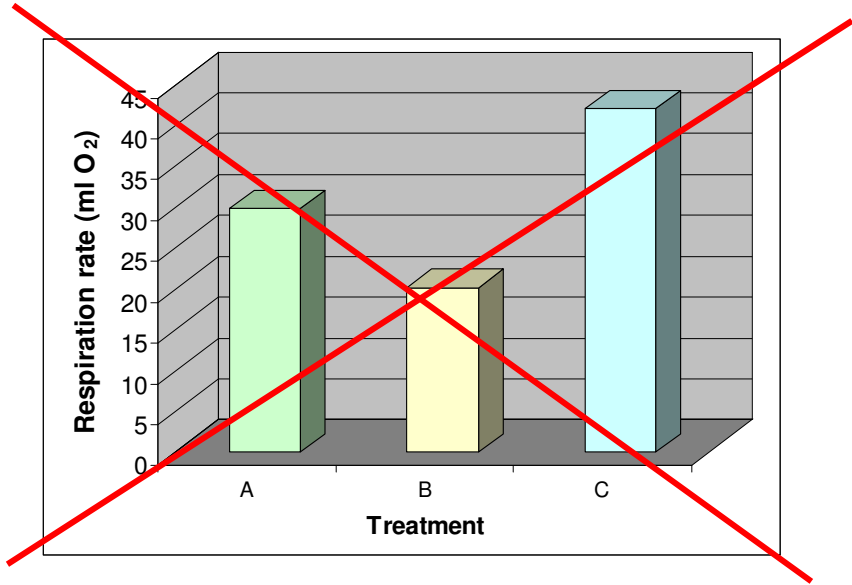


Results: graphs

Box-and-whisker plot



Results: graphs



Methods: graphs summary

- **Never ever use pseudo-three dimensional graphs!**
- Avoid using solid colors or shades of grey – different hatchings or line patterns are better
- Use labeling large enough to be readable after substantial reduction of size (check it!)
- No unnecessary lines, text, etc.
- **Figures should be easy to interpret!**
- Figures are printed on separate pages at the end of the manuscript; captions are printed on a separate page

Discussion

Put your results into the context of furthering knowledge

- *Paragraph 1*
 - What did your study show? How do the results relate to aims and hypotheses formulated in the Introduction?
- *Paragraph 2*
 - Describe strengths and weaknesses of the study/methods
- *Paragraph 3* (possibly more than one)
 - How do your results fit into the current knowledge? Do they agree with the literature or oppose it?
- *Last paragraph*
 - What are the consequences of your study? What should be done next?

Discussion: things **to do** and **not to do**

- **Make a strong message** from your results
- **Be absolutely honest** about any problems, inconsistencies, and limitations of your study
- **Do not** try to discuss your results against every single article relating to your study
- **Do not** over-interpret your results (formulating new hypotheses and forwarding suppositions is OK, speculating is NOT)
- **Avoid** statements like: „Further studies are needed... „

References

- Use only the most important and up-to-date literature (but do not forget that science existed before Internet and valuable data and papers are sometimes decades old)
- Include only published articles and books
- Do not quote second-hand
- Do not exceed ca. 30 references
- Format all references exactly as required for the selected journal