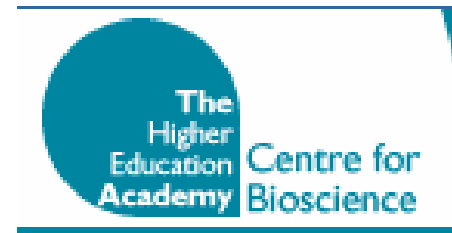




Enhancing the development of experimental design skills in life science undergraduates

Jane MacKenzie and
Graeme Ruxton






Background to Study

- Ability to design and conduct experimental investigations are essential skills for the bioscience graduate
- Current concerns about the value and continued resourcing of the Final year project in the HE sector

“poor or poorly motivated students may just be throwing expensive chemicals down the sink”

Wood (2004)

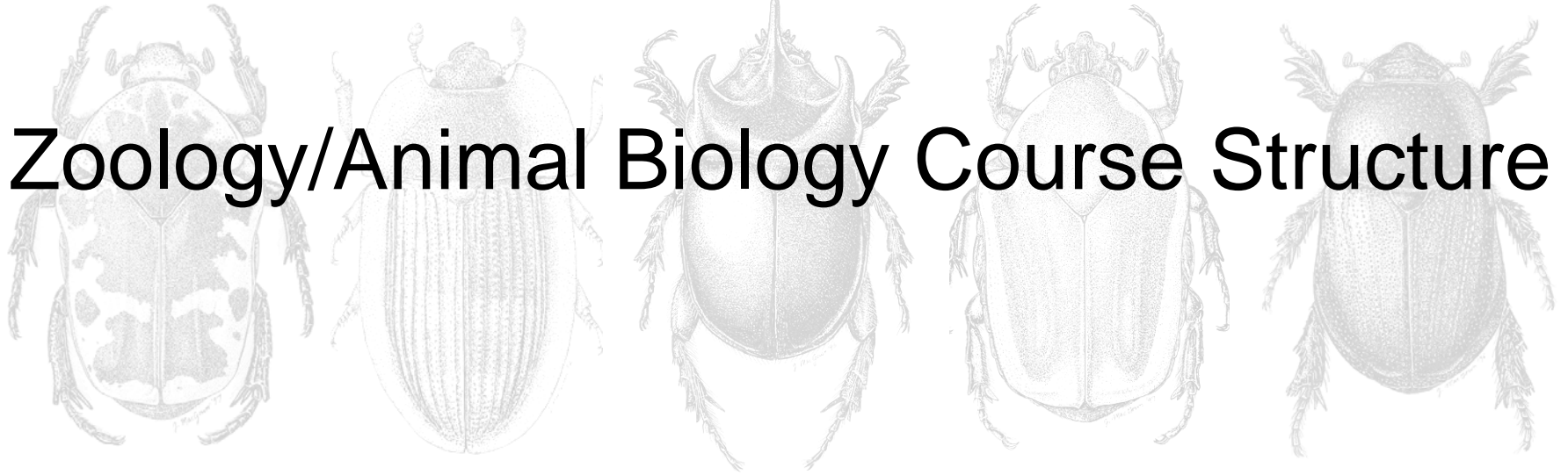
- Perceived gap in the development of these key skills



Context of Study - University of Glasgow

- General faculty entry
- Institute of Biomedical and Life Sciences offering ~ 20 honours degree programmes
- 4 year honours degree programme
- General classes in first and second year
- Degree specific curriculum for 3rd and 4th year
- Final year honours project common to all programmes

Zoology/Animal Biology Course Structure



3rd year

4th year

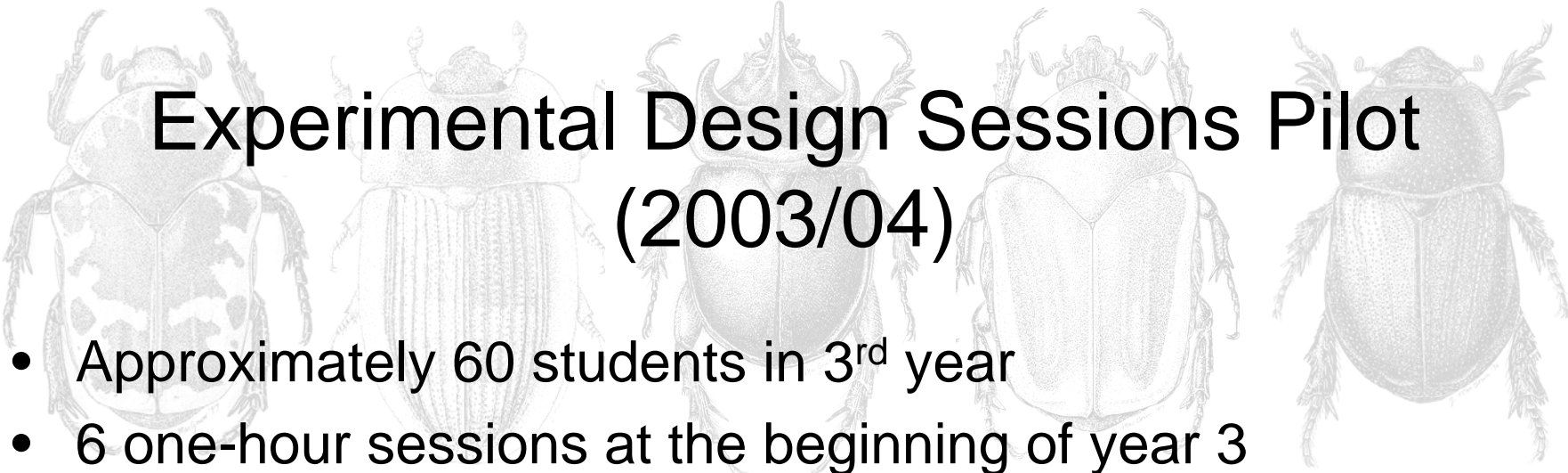
Exptal
Design
Sessions

'Insect'
Project

Final
year
Project

Exptal
Design
Paper

Degree
exams



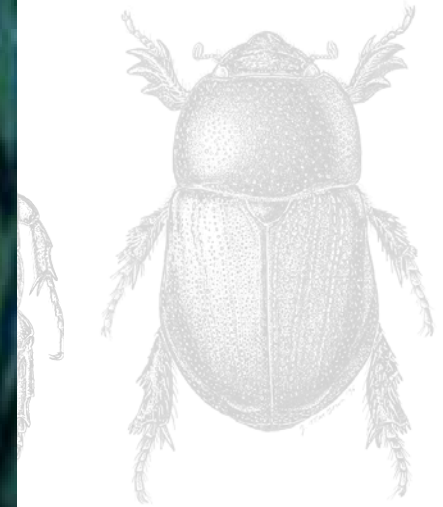
Experimental Design Sessions Pilot (2003/04)

- Approximately 60 students in 3rd year
- 6 one-hour sessions at the beginning of year 3
- Groups of ~15 students with activities designed for smaller sub-groups
- Supported by book and a series of questions to support each chapter
- Students requested to read chapter and attempt questions prior to each session

Three small photographs arranged horizontally. The left photo shows a person in a blue jacket working in a field. The middle photo shows a person in a white lab coat holding a small animal, possibly a mouse, in a laboratory setting. The right photo shows a field of green plants with white markers.

**Experimental
design for the
life sciences**

Graeme D. Ruxton
Nick Colegrave



Trond Amundsen, Norwegian University of Science and Technology
"It may well prove to be the most useful textbook in biology for years."



Sample questions

Salmon parr eat less per day in winter than summer. Suggest at least three hypotheses that could explain this.

Ecologists commonly use indirect measures such as clutch size, feeding rate and mass per unit length as indirect measures of fitness. What are the limitations of this, and why do ecologists persist in using these indirect measures in the face of these limitations?

Mini Practical exercise

Devise a scheme for categorising a person's hair colour. Your scheme must give fine-detailed information but have very low levels of inter-observer variability. Demonstrate the effectiveness of your scheme by presenting data collected independently by several group members on a sample of people passing by this building.



Evaluation of Pilot Year

3rd year

- Post Experimental Design course – student questionnaire
- Post Insect Project – semi-structured interviews with supervisors (4 of 6 supervisors)
- Collection of Insect Project marks

4th year

- Correlation of attendance at sessions with students' Honours project and Experimental Design paper marks versus overall marks



Questionnaire outcomes

- 92% of students agreed (or agreed strongly) with the statement that they would be better at designing their own experiments after the sessions than before
- 92% of students agreed (or agreed strongly) with the statement that they would be more able to criticise the design of others' experiments
- 79% agreed that the discussion sessions were an effective way to learn
- 82% preferred this method of learning to a lecture-delivered course



'Insect' Projects

- End of semester 2
- Students work in groups of 2 or 3 to address an aspect of invertebrate biology e.g. feeding preference of woodlice, wasp nest structure
- Students are supported by an experienced supervisor
- Projects run for 3 weeks
- Assessed by group oral presentation



Supervisors' interviews

Unanimous in the belief that compared to previous years:

- Students engaged more effectively with the projects
- Students required less direct guidance and supervision
- The outcomes of the projects were more successful



“they were very focused and ‘let’s get proper samples’ so that we can really answer the question”

“they were showing evidence of thinking about what they were doing quite deeply, which I don’t think I’d seen before”

“there was evidence of a greater understanding of what an experiment is”

“significantly less [supervision] than in the past, and they did significantly better”

“I thought this is the best year we’ve had for the quality of the science”

Mean Insect Project Marks



3rd Year	Mean mark
2002/03	10.9
2003/04	15.5
2004/05	15.3

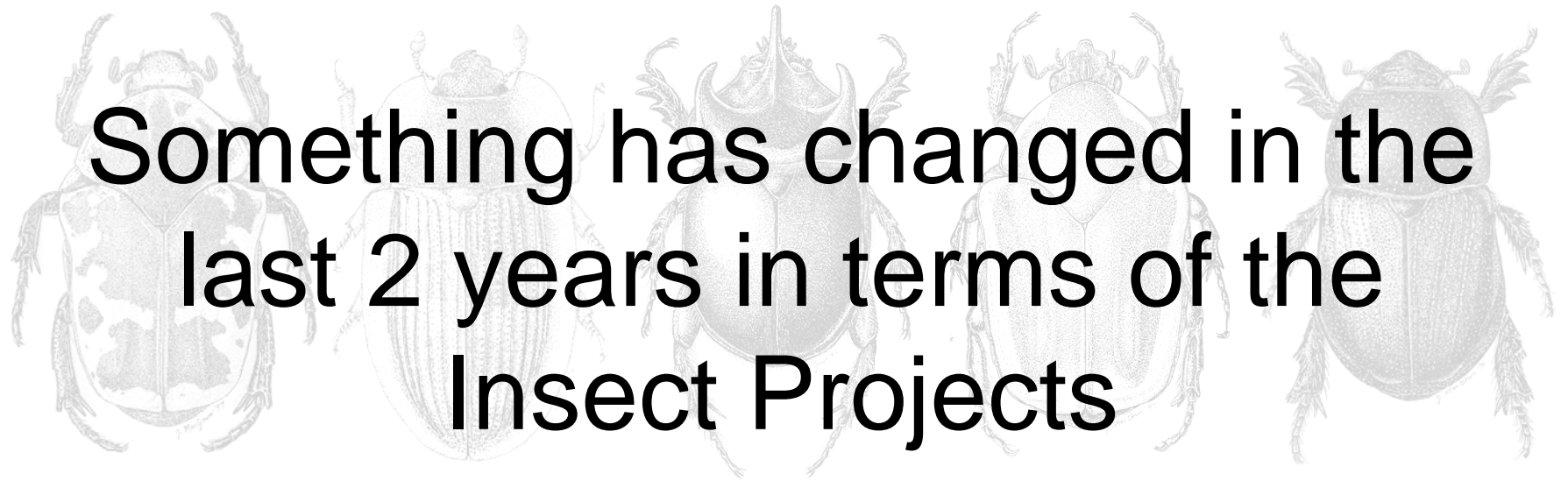
2004 significantly different from 2005 & 2006 (using one way ANOVA)



However....

No significant difference between last and previous years' marks:

- In Final year project
- Experimental Design and Data Analysis paper
- Overall degree mark



Something has changed in the last 2 years in terms of the Insect Projects

Continued evaluation funded by HE
Academy Centre for Bioscience

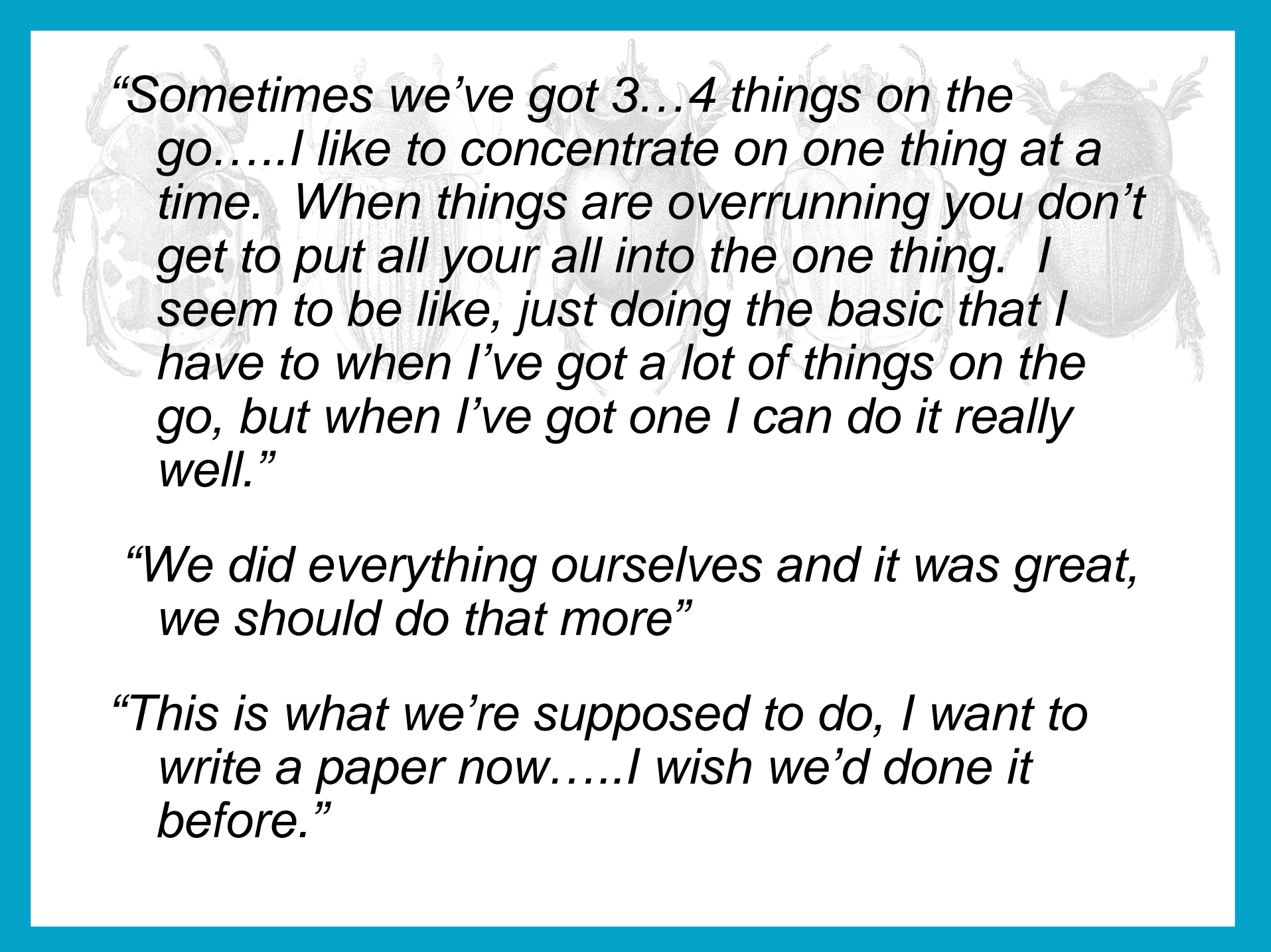


Continued evaluation

Semi-structured interviews conducted with 14 third year students shortly after the insect projects this year

Interviews designed to investigate:

- The timing of the projects
- Student motivation and confidence
- The implicit value placed on experimental design by the inclusion of a formal course component



“Sometimes we’ve got 3...4 things on the go.....I like to concentrate on one thing at a time. When things are overrunning you don’t get to put all your all into the one thing. I seem to be like, just doing the basic that I have to when I’ve got a lot of things on the go, but when I’ve got one I can do it really well.”

“We did everything ourselves and it was great, we should do that more”

“This is what we’re supposed to do, I want to write a paper now.....I wish we’d done it before.”

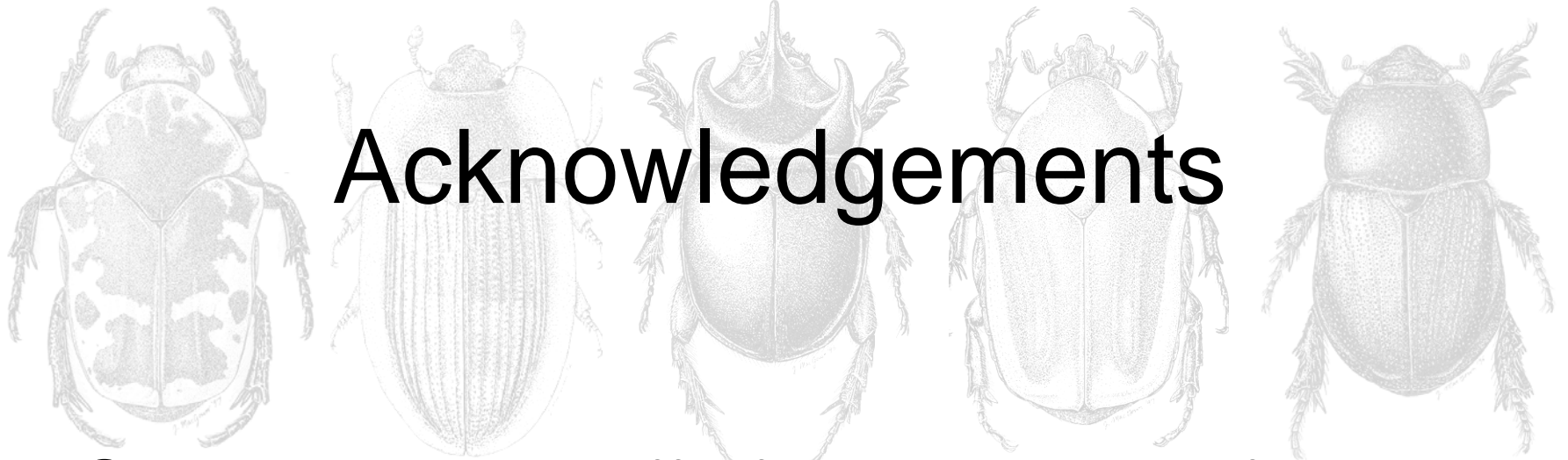


Future aims

Identify themes that influenced students to perform better in the insect projects

Further refine the design and delivery of the experimental design course

Examine why upturn in insect project marks not reflected in final year project marks



Acknowledgements

Students and staff of the Division of
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