Walking with Woodlice

Biodiversity On-line and in the Field

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Abstract: This paper describes the development and implementation of a web-based project that encourages and enables first-hand encounters with the biodiversity of the natural world. Aimed at 7 to 14 year-olds, the project was designed to raise awareness of biodiversity by involving students actively in biological research. The paper explores their use of identification keys and investigates the potential of the Internet as a mechanism for sharing and distributing biodiversity data. The identification tools and the processes of data submission and analysis are described and sample results presented. The paper concludes with a preliminary evaluation of the project's findings.

1. BACKGROUND

The Natural History Museum's website was launched in 1994. From the outset, it was seen as a potentially excellent vehicle for conveying ideas about the life and earth sciences to a much larger and more diverse audience. As with many museum sites, the early content was principally visitor information – about opening times, entrance fees and bus routes – but included something of the nature and scope of both collections and exhibitions (Shaw 1995).

In addition to general improvements in graphic design and enhanced functionality, subsequent elements have increasingly featured active involvement by the virtual visitor. These interactive materials include *Science casebook*, dinosaur datafiles, *The voyage of the Endeavour* and *QUEST*.

The Museum's *QUEST* project – 'Questioning, Understanding and Exploring Simulated Things' (www.nhm.ac.uk/education/quest) – has been described in detail elsewhere (Hawkey 1999, Hawkey 2000). Put simply, virtual visitors use virtual tools to investigate virtual objects, to discover what they can about them, in the manner of a research scientist. Its innovative approach to learning from objects on-line significantly changes the relationship between expert and learner. Critical to its success are the high level of learner choice and decision-making, opportunities to 'engage, explore and build' and for 'scaffolded reflection' (Wild and Quinn 1998). Most innovative is the on-line notebook, where learners can share thoughts and exchange ideas. The positive reception of *QUEST* within the education community encouraged the development of further projects in which the learner engages directly with the scientific research process.

2. RATIONALE, AIMS AND OBJECTIVES

Taxonomy is the science of naming and classifying fossil and living organisms. Systematics goes beyond taxonomy in also working out their evolutionary relationships (UK Systematics Forum 1998). Together they underpin our understanding of biodiversity – the variety of genes, species and ecosystems. While many people recognise this as a 'good thing' globally, there is little understanding of its importance in the local environment. The principal association of biodiversity in the public mind is with tropical rain forests and other distant and exotic habitats. But the UK has biodiversity too, and it extends to every kind of organism. Projects involving members of the public in the collection, interpretation and communication of biodiversity data could make a significant contribution to promoting understanding of biodiversity by concentrating on the local environment. Such projects could also help to compensate for the tendency of the formal science curriculum to reduce – or, even, to omit altogether – the study of taxonomy and systematics.

Walking with woodlice (www.nhm.ac.uk/woodlice) was originally conceived early in 1996, at a time when Internet usage in UK homes and, especially, schools was really quite limited. Development and implementation were therefore delayed for several years until the potential audience was adjudged to be sufficiently large, as reflected in feedback from teachers at the annual meeting of the Association for Science Education. Its launch was finally facilitated by a timely request from the BA's creatingSPARKS festival for an 'on-line biodiversity project'.

The project identified a number of major aims (for the Museum) and intended learning outcomes (for the on-line learner). These are indicated in Table 1.

Table 1. Project aims and intended learning outcomes

	Biodiversity	ICT
The Natural History Museum aims to...	raise people's awareness of UK biodiversity; explore issues of protocol and standardisation relating to the collection, interpretation and communication of biodiversity data	develop interactive science education activities on the Internet; pilot the design of network parataxonomy tools; pilot the use of volunteer recorders in supplying biodiversity data on-line
Learners can...	develop taxonomic skills (use a dichotomous key); appreciate the significance of biodiversity in the UK	use the Internet to exchange data and to communicate with each other and with professional scientists; manipulate and interpret data presented in tables, maps and graphs on-line

In addition to the immediate feedback on the habitats and distribution of the specific organisms under investigation, it was hoped that the project would act as a pilot experiment in exploring and resolving a number of key issues relating to the collection and exchange of biodiversity data. The project would therefore act as a prototype for a potentially much broader application, in which a greater variety of people, be they members of wildlife trusts or other interested non-specialists, will become involved in collecting and recording data about a much larger range of UK species. This aim is reflected in the establishment of the National Biodiversity Network (www.nbn.org.uk), in which The Natural History Museum is playing a major role.

Woodlice were chosen as the group for this experimental project for a number of reasons. They are common and widespread and easily observed, and are not subject to significant seasonal variation. They are readily recognised as a group, but people are not generally aware that there are a number of different species – thirty-seven native to the UK. Woodlice vary little within each species, but display fairly easily identified differences between species – at least for the most common types. In pragmatic terms, woodlice are more inherently dynamic than less active organisms yet easy to locate and catch. They are not easily harmed nor do they evoke phobias!

3. DEVELOPING THE SITE

Having established the fundamental ideas, development was required on three complementary fronts:

- background material of scientific integrity
- interpretation / explanation of this material in ways accessible to the target audience
- the web-site itself.

In addition, promotion of the site to students, teachers and the general public would be essential if sufficient worthwhile data were to be generated, as anomalies in distribution data caused by a limited number of enthusiasts with a restricted geographical range are well known.

Experts in isopod crustaceans in general and woodlice in particular, both within and beyond the Museum, were consulted. In particular, Stephen Hopkin gave advice on possible approaches to adapting his standard key (Hopkin 1991) for this project's particular purposes.

Background information – on biodiversity, taxonomy and systematics in general and on woodlice in particular – was provided in a lively format, together with additional supporting material for teachers, to enable ready linkage with the school curriculum. In addition to promotion on the Museum's own web-site, information about the project was carried in the promotional materials for the British Association's creatingSPARKS festival and in the national press. With the support of the Association for Science Education, a simple poster was distributed to teachers of science.

4. KEY TO SUCCESS?

The dichotomous key is a standard tool in the life sciences. In principle, its very nature – the binary tree – should make its representation by computer very simple. (Indeed, one of the best of the early science software products for primary schools was *Branch*, which enabled young learners to construct and use their own keys.) There are, however, a number of difficulties that have to be overcome in producing a key for on-line use by students or others outside the expert taxonomic community.

The keys that taxonomists use are founded, as far as is possible, on natural groupings and sub-groupings. Each step of the identification process utilises a feature that is present (or of a particular quantity or quality) in one group but absent from the other (or of a different quantity or quality). This has clear scientific advantages, in that each sub-category has integrity, but often leads to the use of features for identification that are very difficult for the non-specialist to interpret. (Such keys also tend to use complex technical

terminology to make fine distinctions. For example, the standard key to UK woodlice (Hopkin 1991) begins, not with the more obvious body shape – cylindrical or flattened? – nor with the ability to roll up into a ball, but with detailed differences in the segmentation of the antennae.)

In developing keys for wider use, it is generally desirable to take a para-taxonomic approach. This is not concerned with the integrity of sub-groups and can therefore use more readily accessible features en route to the identification. A further advantage of the para-taxonomic key is that it does not need to try to include every single species, however rare it may be. Thirty-seven species of woodlice have been recorded in the UK, but fewer than ten of these can be regarded as common. A relatively simple key is likely to be sufficient in the vast majority of cases.

In an earlier study, Tardivel and Morse (1998) compared the performance of undergraduate biology students in using a key to woodlice presented in different formats. They found that user confidence was highest for the computer-based version, but that the results were actually more accurate when using a paper version. This probably relates to a false sense of confidence and greater ease of use, especially given that the full Hopkin (1991) key was used.

Figure 1. Woodlouse wizard: a simple dichotomous key

An earlier Museum project had developed a simple paper-based key to eight species of woodlice (Education Unit 1997). This formed the basis for the *Walking with woodlice* key, but the new version (Figure 1) was modified with the addition of one species and the removal of two others. Such findings and other considerations – including the need for a paper version to use in the field, limitations on budget and on the ready availability of technical support – suggested that a compromise approach would be likely to be most successful in the context of the project. Presented as part of the web-site, the key to the ‘top level’ seven species was produced in two versions. The first has interactive links to further details – both text and high quality colour photographs. The second is a greyscale.gif file (Figure 2), easily printed out for use out of doors. Details of the next most common set of nine species were made available through hypertext links. For the remaining (rare and/or unusual) species learners were referred to Hopkin’s (1991) guide.

5. DATA COLLECTION, SUBMISSION AND INTERPRETATION

There is a tendency to assume that the use of web-based learning material is somehow an alternative to real learning. One of the features of *Walking with woodlice* is that it promotes learning not only in the real (but artificial) world of the classroom or teaching laboratory but also in the real (and natural) world of the biotic environment. The promotion of fieldwork and its interaction – through data recording and analysis – with the electronic realm is a key element of the project.

A simple form was provided on the web-site for recording details of species, habitat and geographical (post-code) information. This was then sent by email directly to the project co-ordinator. Because much of the data was collated into sets by a teacher, student representative or family member it is not possible to exactly quantify the number of individual learners participating in the project. However, over two thousand sets of data were received, the majority of useable quality. As this was a pilot project, each item of data was examined, simple checks made on its veracity and then incorporated into a database from which the distribution maps and other data displays were generated. Only the presence or absence of species in particular locations was required, so duplicates from the same post-code area were disregarded in the data presentation and analysis.

Data was initially analysed and presented as...

- species maps, by postcode (Figure 2)
- species lists, by habitat (Table 2); this ‘raw’ data facilitates further manipulation and analysis by learners

- species biodiversity (richness), by habitat (barchart and piechart).

For comparison, both in terms of the nature of the data collecting process and to explore changes over time, data from earlier scientific surveys (Harding and Sutton 1985) was added to the site. Finally, learners' comments, observations and questions were posted.

Table 2. Frequency of woodlouse species by location (percent)

Species	Location	Building	Coast	Garden	Grassland	Playground	Waste ground	Woodland	Other
<i>Androniscus dentiger</i>		0.08		0.32			0.08		0.08
<i>Armadillidium depressum</i>				0.16	0.08				
<i>Armadillidium nasatum</i>		0.32		4.21	1.78	0.08	0.40	2.51	0.24
<i>Armadillidium vulgare</i>		1.05		8.66	2.10	0.16	0.49	2.83	0.73
<i>Cyclisticus convexus</i>				0.08	0.08				
<i>Ligia oceanica</i>		0.08	0.16	0.24	0.08	0.08			
<i>Ligidium hypnorum</i>					0.08		0.24	0.24	
<i>Oniscus asellus</i>		0.49		9.63	2.91	0.08	0.49	3.88	0.89
<i>Philoscia muscorum</i>		1.05		11.57	3.64	0.24	0.06	4.45	0.97
<i>Platyarthus hoffmannseggii</i>				0.08					
<i>Porcellio dilatatus</i>				0.08	0.01				
<i>Porcellio nidespruinus</i>								0.08	
<i>Porcellio scaber</i>		0.81		12.86	2.99	0.16	0.65	3.56	1.38
<i>Porcellio spinicornis</i>				0.08				0.16	
<i>Trachelipus rathkei</i>				0.08	0.16			0.24	
<i>Trichoniscus pusillus</i>		0.32		4.53	0.40	0.16	0.32	1.86	0.24

6. ENGAGING AND EMPOWERING LEARNERS

In recent years there has been a marked shift of emphasis in the informal learning of science (in museums, science centres and elsewhere) towards engaging and empowering learners (Hawkey 2001). This has already begun to supplement – and may ultimately supplant – the more traditional didactic, fact-laden approaches that are also being questioned in our schools.

Although *Walking with woodlice* can call upon the leading experts in the field, it is less concerned with approving and validating the findings than with encouraging participants, having submitted their own data, to join in analysing and commenting on the results. The project's next step, therefore, was to prepare a series of prompts to stimulate further minds-on participation to complement and extend the earlier hands-on involvement.

They include...

- Which are the most/least common species?

- Can we 'trust' these results? Or any scientific results?
- What did the survey not find out? What else would it be useful to find out?
- Where were no results recorded? Does this mean there are no woodlice there?
- What are the limitations of the survey? What could be done next?

It appears, however, that learners are initially less confident in making comments on the data than they were in submitting it. This may be natural reticence, or it may be a reflection on the presumed hegemony of experts.

7. EVALUATION

The nature of the UK climate (and the distribution of daylight hours) means that both woodlice and learners are much more active in the environment from April to October. The organisation of the academic year (September to July) means that work begun in the summer is unlikely to be followed up in the autumn. Feedback from teachers suggests, however, that repeating the project will bring an increased rate of response and continuing engagement, as the previous year's data will be available from the outset.

Some indication of the level of awareness of biodiversity (both in general and with specific reference to woodlice and the use of keys) emerges from the nature of the observations submitted in response to the on-line invitation to comment on the survey results – and from the results themselves. While this is not direct evidence of the effect of *Walking with woodlice*, it will form a useful baseline for future work. More immediately useful material comes from unsolicited feedback, which provides helpful pointers, even though it is not necessarily representative.

Use of the keys under supervision, for example within the Museum's *Investigate* gallery, has borne out their general effectiveness. The level of public participation has confirmed the worthwhile nature of the project and has encouraged the Museum to extend the exercise.

There is, inevitably, some doubt as to both the validity and reliability of the data on species distribution. Broadly, however, the results are as might be expected, and concur with expert opinion. A cursory glance at the results, however, can be misleading and certainly raises questions for further investigation:

- Why are there no records at all from certain parts of the UK?
- Are the six most commonly identified species really more common? (Table 2) Or are they more frequently identified because of their location in the top-level key?

- Is *Armadillidium nasatum* extending its northerly range, as some experts have suggested? (Figure 2)
- Does the location data tell us more about woodlice or learners? Is it of any value?

Figure 2. Distribution of *Armadillidium nasatum*. (Note the records from NE England, not found in previous surveys.)

8. FUTURE DEVELOPMENTS

Three areas are under active consideration as the project evolves. One concerns the nature and presentation of the identification key. Opportunities will be taken to develop further, more dynamic versions of the on-line keys and also to explore approaches other than the basic dichotomous model, such as Karnough mapping. The second area relates to technical matters and the need for an automated system to generate tables, graphs and maps directly – and, preferably, in real time – from the data. The third concerns the possible application of similar approaches to different organisms, and, if so, which group. Ladybirds, bumblebees and butterflies are the groups most frequently suggested. Any of them could build upon the initial success of *Walking with woodlice* in exploring biodiversity on-line, but none has all of the advantages of the terrestrial crustaceans.

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BIOGRAPHY

Roy Hawkey was a science teacher and university lecturer in science education before becoming Head of Education at The Natural History Museum, where he has been responsible for a number of innovations such as *QUEST* and *Investigate*. Roy has published widely on science education and given conference papers and presentations on a variety of topics, although his principal interests are the development of resources for independent and constructivist learning, the role of ICT in science education and the public understanding of science. He is currently a Visiting Research Fellow in the School of Education at the University of Brighton.