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Collections combine information about places, times, people and species. They represent actual transactions, dated moments in history as valuable as dated letters and contracts in terms of the amount of information can be related to and derived. By using examples from the Midlands of England (UK) and the FENSCORE National Database the author hopes to show how collections have a value in providing new information of a social historical as well as a scientific interest.

There are many aspects that are illustrated and that will repay further study. For example collections represent scientific and personal fashions as well as the pursuit of science. The situation of the collector collecting varies; they may be on holidays, or commuting, or even coming under enemy fire! They may result from a personal part-time hobby or a full-time burning obsession. They may involve extreme personal danger or inspire extreme envy and theft. The paper attempts to show how the study of collections can both pose and answer questions which have great social and historical interest. Why do people collect? Is collecting a sexually dimorphic characteristic?

The sources of collections are also important. The geographical origins illustrate not only the favourite haunts of individual collectors but also, on the wider scale, the extent and wealth of worldwide contacts within the old 'empires' of Europe and the UK in particular. Contacts change over time. Whilst some of these contacts have declined in recent years others have grown; for example the rapidly increasing collections from Eastern Europe and selected third world countries reflect the increase in academic contacts with these areas.

Through this type of analysis the wealth of social data that are explicitly available within collections and some of the implicit connections with the wider social context can be shown, placing natural history collecting and collections more at the centre of worldwide human endeavour.

PRACTICAL EXAMPLES OF THE APPRAISAL AND VALUATION OF NATURAL HISTORY COLLECTIONS.

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Valuation in the natural history area and presentation of the numerical results in an appraisal report depends on a number of considerations. The use of photographs is sometimes the best indicator of what an object is and what it is not.

Examples of how photographs should be taken will be shown and the errors of description without photographs will be described.

THE CULTURE COLLECTION OF ALGAE AND PROTOZOA - A LIVING RESOURCE.

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Abstract

The primary remit of a protist collection, in this case micro-algae and free-living non-pathogenic protozoa, is broadly similar to that of other collections of biological material, that is to act as a depository and to make the material accessible for end-users, effectively a genebank. At the Culture Collection of Algae and Protozoa (CCAP), one of the UK microbial service collections, this involves collecting, maintaining and preserving the protists, and providing viable, authentic, documented cultures and their associated information to the scientific community.

The live cultures form the core of the collection. Their scientific value primarily lies in their current and past use in taxonomic and other research fields and the extensive literature published citing CCAP strain numbers. In terms of conservation of biodiversity, the collection arguably encompasses one of the largest degrees of biodiversity which can be found in any collection or genebank. This is particularly true for the algal collection which currently includes representatives of 50% of the algal species lodged in culture collections worldwide. They are also widely employed in teaching science at both secondary and tertiary levels of education.

The commercial value of cultures is more difficult to quantify. For those which are regularly employed commercially eg. *Selenastrum capricornutum* CCAP 278/4, which is used in ecotoxicity testing, a value could be calculated using its potential income generation from sales. Other commercially used organisms eg. those screened for novel pharmaceuticals, have the potential to generate substantial income, however the likelihood of a product being developed is low, even where pharmaceutical activities are observed. Most strains held in any major collection are probably of little direct commercial value, however, their scientific value and the costs which would be incurred in replacing the culture should it then be required demonstrates the necessity for their retention in the collection.

This paper discusses the above points in fuller detail and also focuses on the additional implications of maintaining a culture in a live or a preserved state.

Introduction.

The Culture Collection of Algae and Protozoa (CCAP) was founded by Professor Ernst Pringsheim at the Botanical Institute of the German University of Prague in the 1920's. Pringsheim and his cultures moved to England in the 1930's where the collection was enlarged and eventually taken over by E. A. George for Cambridge University. In 1970 these cultures formed the nucleus of the Culture Centre of Algae and Protozoa at Cambridge, financed by the Natural Environment Research Council (NERC). In 1986 the cultures and their associated activities were transferred to the Institute of Freshwater Ecology (IFE) Windermere laboratory (freshwater algae and all protozoa) and Dunstaffnage Marine Laboratory (DML) near Oban (marine algae). The CCAP currently maintains approximately 2000 strains of algae and protozoa at these two sites.

This paper discusses the various roles and functions of CCAP, a protist culture collection. Both primary and secondary roles of the collection and its associated scientists are detailed. The commercial, educational and scientific value of the algae and protozoa retained are also discussed. In the final section, future developments and the merits of maintaining a collection in a live or preserved state are discussed.

Primary remit of microbial culture collections.

The primary remit of all microbial culture collections is to act as a depository of strains. In the case of CCAP the range of micro-organisms is restricted to prokaryotic cyanobacteria (blue green algae), eukaryotic microalgae and free-living non-pathogenic protozoa. The collection functions as the national service collection of algae and protozoa in the UK and is linked with other service collections world-wide via the World Federation for Culture Collections (WFCC). Within Europe there is liaison between collections via the European Culture Collection Organization (ECCO) and nationally via the United Kingdom Federation for Culture Collections (UKFCC).

Most of the major protist culture collections located in Europe, North America and Japan act as service collections, performing not only the primary basic remit of being a microbial culture depository, but also providing cultures for third parties (Table 1). These collections are charged with the task of collecting or obtaining cultures from other researchers, the organisms should then be purified if possible to axenic clonal cultures, or at least in the case of the algae to unialgal cultures. For protozoa this may not be technically possible, but where achievable, clonal, axenic or monoxenic strains are preferred. Each organism should then be authenticated and a maintenance/preservation protocol developed prior to accession into the collection. The most important component of the primary remit is the maintenance/preservation of the cultures under conditions which produce maximum strain stability, prevent genetic drift, and allow the culture to remain in a viable state. The provision of viable, stable cultures and their associated information to outside bodies/researchers is the end point of this process. This involves the development of an administration which is responsible for the production of strains, their packaging and posting as well as the invoicing and other financial and regulatory considerations.

Culture collections including CCAP perform a number of additional functions and also provide a range of services, these are discussed in greater detail below.

Secondary roles of culture collections.

CCAP, as for some other collections, is associated with its host research institutes, and is as a result involved in the research programs of IFE and DML, this includes the provision of authentic cultures and also the active participation by individual scientists who are connected with culture collection. Areas of research include microbial taxonomy, physiology, and ecology, as well as research into preservation techniques and various aspects of algal biotechnology.

CCAP is also actively involved in education, previously this was largely restricted to the provision of reference cultures for research and teaching, as well as interaction with research students working on projects associated with the collection. Now, courses covering algal identification, culturing, basic physiology and preservation are held periodically. Also in the past, CCAP only produced catalogues with all other publications tending to be contributions to scientific publications. Over the past ten to fifteen years this has expanded to cover educational resource materials including booklets, practical experiment kits and videos.

The role of CCAP in biotechnology.

Most of the major collections, including CCAP, are currently required to provide services and information for industrial clients as well as their more traditional role as suppliers of cultures to the academic community. Some of these services are discussed in greater detail below.

The provision of pure/axenic well documented cultures is one of the core activities of culture collections, this is becoming increasingly important in biotechnology. The provision of axenic cultures is particularly relevant for those who intend to employ mixotrophic or heterotrophic culture systems. In addition, the isolation, purification and identification of cultures for commercial customers is occasionally undertaken by CCAP. The development of media and culture conditions are usually associated with this service.

CCAP offers a safe depository for commercially valuable cultures. This ensures that cultures are maintained at a second site, in case there is accidental loss of the master stock cultures held by the customer. This facility allows continual access of the owner to their culture, but prevents any third party obtaining it. CCAP along with a number of other algal collections is a signatory to the Budapest Treaty (1988) and is an International Depository Authority (IDA), this allows commercial concerns to deposit strains of algae for patent purposes, again there is restricted access to the cultures lodged.

A commercial usage of microalgae, which is on the verge of algal biotechnology, is their use as bioassay/ecotoxicity testing organisms, see Table 2. This usage is increasing in importance as ecotoxicity testing becomes a statutory requirement for new products. CCAP is also a major international supplier of marine algae for use as food organisms for larval shellfish, or for invertebrates which are then fed to larval fish. All the strains listed below (Table 3) are easy to maintain, of a suitable size and almost all contain significant amounts of the highly unsaturated fatty acids; EPA 20:5(n-3) [eicosapentanoic acid], or DHA 22:6(n-3) [docosahexaenoic acid]. The provision of starter cultures for aquaculture is regularly undertaken by CCAP and this could easily be expanded to provide larger volumes of axenic starter-cultures for other applications.

Contract research, including screening for pharmacological activity and studies on the biological control of algae have been undertaken. This area could easily be expanded to include; strain selection, and mutant generation to increase productivity for a commercial partner. Furthermore, the development/improvement of production processes (culture systems), down-stream processes and product development could be carried out in association with a commercial partner or customer.

Finally culture collections by their nature have a large amount of in-house expertise and this allows them access to a bank of information, which could be used to provide literature surveys and paper feasibility studies for commercial customers. Future developments in this area, including the growing interest in algal data bases will undoubtedly improve this aspect of the services which CCAP currently provides.

The value of CCAP

The value of some of the commercial and educational aspects of CCAP have been outlined in the sections above. CCAP, as in other collections of this type, can not generate

Table 1. List of major protist culture collections[1]

Acronym	*Name*	*Country*	*No. of cultures* *Algae*	*Protozoa*
ASIB	Algensammlung am Institute fur Botanik.	Austria	1570	—
ATCC	American Type Culture Collection.	USA	108	950[2]
CALU	Collection of Algal Cultures Leningrad Univ.	USSR	600	—
CCALA	Culture Collection of Autotrophic Organisms.	Czech Rep.	498	—
CCAP	Culture Collection of Algae and Protozoa.	UK	1631	328
CCMP	Provasoli-Guillard Centre for Culture of Marine Phytoplankton	USA	1000	—
CS	CSIRO Culture Collection of Microalgae.	Australia	300	—
EATRO	Uganda Trypanosomiasis Research Organisation.	Uganda	—	550[2]
IAM	Institute of Applied Microbiology.	Japan	500	—
IPPAS	Culture Collection of Unicellular Algae.	USSR	340	—
LMS	Carolina Biological Supply Co.	USA	165	30
NEPCC	North East Pacific Culture Collection.	Canada	340	—
NIES	Microbial Culture Collection	Japan	500	6
NIVA	Culture Collection of Algae (NIVA)	Norway	260	—
PCCIP	Pasteur Culture Collection of Cyanobacterial Strains	France	200	—
SAG	Sammlung von Algenkulturen.	Germany	1400	—
SVCC	Sammlung von Conjugaten Kulturen.	Germany	400	—
UTEX	Culture Collection of Algae at the Univ. Texas. at Austin.	USA	2089	—

[1] Major collections = Collection with >200 cultures lodged.
[2] Largely parasitic/pathogenic protozoa.
(Day and Turner, 1992; Takishima *et al.*, 1989).

Table 2. CCAP strains used for routine ecotoxicity testing

Organism	*CCAP No.*	*Other reference Nos.*	
Freshwater			
Selenastrum capricornutum	CCAP 278/4	UTEX 1648	ATCC 22662
Scenedesmus subspicatus	CCAP 276/20		
Chlorella vulgaris	CCAP 211/11b	SAG 211-11b	UTEX 259
Marine			
Skeletonema costatum	CCAP 1077/3		
Skeletonema costatum	CCAP 1077/5	CCMP 1332; SKEL	
Phaeodactylum tricornutum	CCAP 1052/1A		

(Day and Turner, 1992)

Table 3. CCAP algae routine algae aquaculture

Flagellate algae		*Diatoms*	
Isochrysis sp.	CCAP 927/14	*Chaetoceros calcitrans*	CCAP 1010/5
Isochrysis galbana	CCAP 927/1	*Thalassiosira pseudonana*	CCAP 1085/3
Tetraselmis chui	CCAP 8/6	*Skeletonema costatum*	CCAP 1077/5
Tetraselmis suecica	CCAP 66/4		
Pavlova lutheri	CCAP 931/1		
**Rhodomonas* sp.	CCAP 995/2	*Now renamed as *Rhinomonas reticulata*	
**Chroomonas salina*	CCAP 978/28	var. *reticulata*	
Others			
Chlorella salina	CCAP 211/25		
Chlorella sp.	CCAP 211/46		
Chlorella sp.	CCAP 211/78		
Nannochloris atomus	CCAP 251/4A		
Nannochloris atomus	CCAP 251/4B		
Nannochloropsis oculata	CCAP 849/1		
Nannochloropsis gaditana	CCAP 849/5		

(Tompkins *et al.*, in press)

Table 4. The number of species of microorganisms compared with those maintained in service culture collections

	Number of species		*Number of species in culture collections*	*Number of species in CCAP*
Group	Described	Est. total		
Algae	40,000	50,000	1,600	800
Bacteria	3,000	30,000	2,300	0
Fungi	69,000	1,500,000	11,500	0
Protozoa	nda	nda	nda	215
Viruses	5,000	130,000	2,200	0

Est. — Estimated.
nda — No data available.
Based on data compiled by Hawksworth and Mound (1991).

sufficient money to cover its costs. Current income from sales and services is >£25,000 per annum; however, this is only a fraction of the full economic costs of running the collection.

Undoubtedly, increased sales and the expected expansion of biotechnology will increase the income generated. However, these alone can not justify the expense of running CCAP. The major justification, has to be the scientific and historic value of the collection. The vast amount of scientific literature citing CCAP strain numbers make the collection effectively irreplaceable. Even to contemplate the collection, reisolation and purification of a replacement for CCAP's current holdings would probably cost 1 - 2 million pounds. In addition, increased interest in taxonomy and the need to conserve biodiversity, both *in situ* and *ex situ*, particularly post-Rio convention, provide additional political and scientific justification for CCAP. The role of conserving biodiversity is particularly relevant as CCAP currently retains 50% of the algal strains maintained in culture collections (Table 4).

Future developments

At present culture strains are primarily maintained by serial sub-culture, although approximately 30% of the algal strains and 2% of the protozoan strains are cryopreserved (stored frozen at -196°C). In order to maintain genetic stability most effectively, research is continuing to develop protocols to increase the number and diversity of cryopreserved organisms in the collection. Increasing the number of cryopreserved organisms, not only guarantees their genetic stability, it also reduces the amount of man-power required and hence costs of routine maintenance. This method has one major disadvantage, that is the loss of the ability to respond immediately to a customers request for a culture. Only small volumes of certain cultures can be successfully cryopreserved, therefore frozen material needs to be thawed, used as an inoculum, and a fresh culture generated prior to dispatch to a customer.

Other planned future developments include: increasing the number, and diversity of strains in CCAP; improving the availability of data on-line, accessible to customers; expanding the key research areas of preservation, taxonomic and biotechnological research; expanding CCAP's role in secondary and tertiary education. All of these are dependent on the future structure and stability of culture collections within the UK. The recent Office for Science and Technology review on culture collections (1994), has suggested major restructuring of the UK microbial culture collections. It is however envisaged that CCAP will form a key component of the proposed UK culture collection and will be retained in its current format. This review has still to be accepted as government policy and its acceptance will be directly linked with the results of the Governmental efficiency scrutiny on public sector research.

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STROMBUS LISTERI GRAY, 1852 (MOLLUSCA; GASTROPODA); MORALS TO BE LEARNT FROM DAMAGE TO ONE OF THE OLDEST KNOWN DOCUMENTED MUSEUM SPECIMENS - A RETROSPECTIVE VALUATION.

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Introduction

Between 31 August and 6 September 1986, the Ninth International Malacological Congress (Unitas Malacalogia) was held in Scotland. The main sessions were held in Edinburgh but one of the days included the opportunity for delegates to view an exhibition on the "History of Shell Collecting" curated by F.R. Woodward , and installed in Glasgow Museum and Art Gallery especially to coincide with the congress. This in itself included the launch of the new edition of the work by Dance (1966) Shell Collecting: an Illustrated History, retitled as A History of Shell Collecting, which took place on 3rd September, 1986. One of the items featured in the exhibition and the book, a mollusc of great interest, had met with a most unfortunate accident the day before. The story of the shell and the lessons to be learnt from this event are described below.

The specimen

The history of the shell, which has connections with the oldest public museum in Britain and is one of the oldest known documented natural history specimens, was only realised in recent years. This brief history of Strombus listeri is based on Dance (1986) and Dance & Woodward (1986). Glasgow University housed the specimen, the only one known to have come from Tradescant's 'Ark', as the result of having acquired Dr John Fothergill's (1718 -80) collections through those of Dr William Hunter (1718 - 83), whose bequest formed the basis of the Hunterian Museum in Glasgow. (Not to be confused with the Hunterian Museum founded four years later in 1811 in London at the Royal College of Surgeons of England which has at its origin in the collections of William's brother, John Hunter (1728 - 1821).)

In 1852, Thomas Gray[1] described Strombus listeri as a species new to science using the specimen from Hunter's collection. He referred to the similarity between it and an illustration in the first edition of Martin Lister's Historia Conchyliorum, a pioneer iconography of shells of the world, published between 1685 and 16922 . Gray even conjectured that it may have been the same shell because of it apparent age and physical similarity to the figure although he had no means of proving this assertion (Gray, 1852). This is not the place to give the detailed evidence confirming this, which is planned for separate publication.