UNDERWATER EXPEDITIONS

Edited by Rob Palmer

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AN INTRODUCTION TO UNDERWATER EXPEDITIONS

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In common with all types of expedition to a particular climatic or physical region, underwater expeditions have their own logistical and administrative problems.

Underwater expeditions can take place in tropical, temperate or arctic waters, and thus the logistical aspects of such expeditions can stray well beyond the sphere of the underwater realm itself. This volume makes no attempt to discuss the surface logistics of extreme environmental surface conditions, instead the reader is recommended to obtain the relevant Expedition Advisory Centre (EAC) publications that cope with such conditions, and use those in conjunction with this volume. Nor will we try and unravel too many of the problems of human relationships, fundraising, or other similar administrative and logistical aspects of expedition organisation, which are covered in more detailed form in the Expedition Planner's Handbook and Directory, except where these have a direct relationship to diving expeditions. Equally so, there are extreme aspects of underwater research and exploration which have no place in a general publication such as this. Diving to extreme depths (i.e. over 60 m) or using gas mixtures, or saturation diving, cannot adequately be covered. Very few amateur diving expeditions will consider using such techniques, however.

1.1 ADMINISTRATION

The general administration of a diving expedition will be very similar to a standard surface expedition, varying on a local scale to meet with local diving regulations or surface environment. The logistics of general expedition organisation are covered very well in Nigel Gifford's Expeditions and Exploration and the EAC's Expedition Planner's Handbook and Directory. The use of these publications in conjunction with this manual is thoroughly recommended; the human side of expedition planning is as important as the eventual objectives in the smooth running of a project, and fundraising and administration is too complex a procedure to gloss over in a few lines.

1.2 PLANNING

It is often not realised that the field stage of an expedition is a bit like an iceberg; the fun bit is the piece that sits above the sea, the bulk of the monster is underneath, out of sight. Expeditions are like that too, for the field stage to be successful, someone is going to have to put in a lot of hours of unpaid tedious work long beforehand to make sure all has at least the semblance of smoothness in the field. The same goes for after the expedition returns. The post-expedition phase of result analysis, writing up, publishing reports, returning equipment and materials, usually takes as long as the prior organisation. Expect an expedition to last at least eighteen months, or even longer, in real terms, for a field phase of four to six weeks.

Prior research is extremely important. All the relevant maps, charts and previous information on your expedition area and its underwater aspects should be gathered together at an early stage.

Local diving regulations may well be one of the main deciding factors in early planning, and it is a good idea to make early contact with a reputable diving organisation (perhaps an academic one, if the expedition has an academic content, or a sporting one, if the expedition is simply exploratory in nature) in the host country, to check whether the planned underwater work is both practicable and legal. Some countries, for example, have strict rules regarding decompression diving (eg. the Philippines) or diving in any form at all (Spain, Greece). Often such problems can be overcome with prior diplomacy, but they need to be known about before such discussion can take place at all.

The UK's own Health and Safety Executive rules can apply to diving from British vessels abroad, if such diving is professional in nature (i.e. someone is being paid) or if it takes place within the UK. for payment. It is possible to be exempted from many of the regulations if the diving is taking place for scientific purposes, as most expedition diving will be, and information on this is available from the Underwater Association.

There will also be organisations within the host country who will have an interest in your work: museums, research establishments or environmental organisations. It is probably very much in your own interest to make an early contact with these also, as they can give both practical (and occasionally logistical) help both before, during and after your field stage. Some background research before you contact these, perhaps through prior workers in the field, or through research establishments in the UK, might be advisable. It is equally possible to get involved in someone else's political, social or personal animosities in your field area if you make prior contact with the wrong people, or in the wrong way!

1.3 AIMS

The aims of the expedition should be clearly and unambiguously defined. Is it sporting; ie do you intend to dive in a remote and undived area simply to see what is there, and possible to record it by photography and simple mapping? Does it have a valid research motive, be it biological, archaeological or whatever? Be honest with yourself, the term "expedition" is one of the most over-used in the adventure world today. If you are simply wanting an adventurous holiday, go to a specialist travel company. Your life will be much easier, and you will probably enjoy yourself more, for less outlay in both time and cash. If you are really planning a genuine expedition ("journey or voyage with definite purpose" - Popular Oxford Dictionary) then decide what that purpose is, and if it is a valid one. Once you have decided, you will be involving many people in your decision, both team members and others within the diving world. You will have taken on a responsibility that probably exceeds your preliminary view of the scene.

So plan well. Take note of what others have achieved on similar expeditions, and how they have achieved it. Contact them, or read their reports (the RGS Map Room has an enormous stock of expedition reports, available for public scrutiny) and learn from them. Plan to do better!

Minutae: always remember these. It is one thing to be aware of the equipment you will be taking with you, the broad view of your expedition purpose, the detailed schedule you hope to achieve and to completely forget about things like tide tables, weather reports, local transport timetables and the like, and where you will obtain these in the field. When you select your team, (or your team selects you) apportion tasks to everyone. The role of expedition organiser is ideally one of delegation, and then ensuring all the delegated tasks are done. Although it seems like it, the leader does not do everything, and if he or she tries to, then much will end up being left undone. The minute details of an expedition tend to be remembered with efficient delegation, and efficient co- ordination. Unless your team members are selected with their ability in mind, the expedition organisation and results are going to suffer. Get people whose previous experience, expedition or no, allows them to make a useful contribution to the organisation.

1.4 PERSONNEL

Choosing personnel for an underwater expedition should be done honestly, with due regard for the eventual aims of the project. Simply choosing one's friends is fine for a small expedition with limited aims to a not too distant corner of the world, but doing the same for a major research project would be a disaster.

One of the paramount considerations in underwater expeditions is diving safety. It is no use coming back with the most tremendous results and a casualty list as long as your arm. Expeditions are not wars. Make sure that all the divers involved with the project are working safely inside their limits and experience. If a part of the programme is likely to challenge the experience of some of your divers, that is fine, but allowance must be made for this in the planning stage, and the individuals involved must be aware of, and capable of, being challenged in such a particular fashion.

Chose your team to match your aims. Do not be afraid of having a practical hierarchy, with some divers being allocated to particular tasks according to ability. Try to avoid this becoming a sociological hierarchy: you are likely to have enough problems with individual egos without creating more! Anticipate the areas of responsibility you will have to staff: compressor management and maintenance, medical aspects, photography, biology, boat-handling and maintenance, cooking, general assistance, and the like. Individuals can often manage more than one of these, but do not try and give too much responsibility to anyone, in case they get overloaded. If the chosen individual has not got much in the way of prior experience with his or her particular area of responsibility, get them on a training course, using the equipment or techniques they will be using in the field. Expeditions are no place to learn basic techniques, they are the time to apply them.

Do try and take at least a core of people whom you know personally, by friendship or reputation, and can trust to produce results. Be wary of anyone you have no prior knowledge of, at least make an effort to find out about their ability, personality and previous experience from impartial sources. If in doubt, don't take them. There have been several expeditions on which a member has crept in only by dint of being boyfriend/girlfriend/casual acquaintance of another member and proved to be an unnecessary disaster. Be firm on this point; you have responsibilities to others and must shoulder them. No-one said it was going to be easy.

Take enough people, but don't take too many. It is very easy to get carried away, and involve too many people for finances or logistics , or your aims themselves , to support. Establish how many members, with which skills, are the minimum necessary to safely achieve your aims, and add a couple of general assistants on, who should be versatile enough and experienced enough to help out where needed.

If you do find yourself lacking in experienced personnel, try placing an advert in the diving press, staling concisely what the aims of the venture are, and follow that up to applicants with a more detailed description, by letter or telephone, of what their potential involvement would be. Don't be embarrassed about wanting to see qualifications, or about asking for references. If it is underwater scientists you need, try the Underwater Association Newsletter, or one of the more specialist periodicals like Marine Conservation, or the magazine of the British Society of Underwater Photographers (BSoUP). Be honest with them, and don't try to offer more than you can provide. Tacking "underwater science* on as a fund-raising carrot may do you, and others, more harm than good if you don't return with the goods. If you genuinely would like to add a scientific flavour to an exploratory expedition, ask for expert advice, through appropriate channels (like the Underwater Association or Marine Conservation Society). For expeditions intent on tropical waters, think about the "Reefwatch" project (see 1.7), which is designed for divers less experienced in marine biology, but who wish to make a positive contribution to biological observation in the marine environment.

1.5 COMMUNICATION

The importance of pre- and post-expedition communication between team members, sponsors and the rest of the world cannot be too greatly stressed. Regular contact between team members, via letters, telephone and news sheets, is essential both before the expedition, to ensure that everyone is aware of what is being planned, and after the expedition, so that reports can be produced, sponsors thanked, and affairs wound up in a satisfactory manner.

Whatever the aims of the project, or its size, a report of some sort should be produced. For a small affair, it can be a few sheets of photocopied A4, tidily staple-bound, using materials from the town stationer. For larger, more professional affairs, it can be a bound volume, with accompanying maps and photographs, perhaps also with visual aids such as slide sets, posters or films. Try and make it as smart and professional as possible however, and include some money for it in the budget. Distribute it to all the relevant organisations, both in the UK. and your host country, to sponsors, and to the expedition members themselves. If the contents warrant (and if you have done the job properly, they should) send a copy to the RGS Expedition Advisory Centre for others to access, and to the major copyright libraries.

If your expedition is newsworthy, try and set up contacts within the media world who will continue to report its activities in the field, and on its return. Whatever you are doing will probably have local if not national interest - possibly even international - so make sure you are geared up to cope. Don't be naive and do it all for nothing. Photographs command some fee, even in local newspapers, and media interest can be a definite source of income if handled subtly. Try and get someone who knows a bit about it to act as your at-home Public Relations person, with whom you can get in touch with from the field.

Above all, do your homework, and try and learn from the work and experience of others. Diving expeditions are very complex things to run, and those who have had all the headaches and made all the mistakes before are generally more than happy to try and help others coming after to avoid them. You will probably be doing the same yourself one day.

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Expedition Advisory Centre publications include manuals for: *Tropical Forest Expeditions, Desert Expeditions, Polar Expeditions, Caving Expeditions* etc. Available from Expedition Advisory Centre, I Kensington Gore, London SW7 2AR.

Marine Conservation. Magazine of the Marine Conservation Society, 9 Gloucester Road, Ross-on-Wye, Herefordshire. HR9 5BU.

1.7 USEFUL ADDRESSES

British Sub-Aqua Club, Telford's Quay, Ellesmere Port, Ellesmere Port CH65 4FL. tel 0151 350 6200, Fax 0151 350 6215, Email : postmaster@bsac.com, website: www.bsac.com

British Society of Uwater Photographers, 103 Charmouth Road, St Albans, Hertfordshire, AL1W 4SG. email peter.tatton@btinternet.com, website: www.bsoup.org

Confederation Mondial des Activites Sub-Aquatique (CMAS), The World Underwater Federation HQ (Rome): +396-3751-7478

Coral Cay Conservation Ltd, The Ivy Works, 154 Clapham Park Road, London, SW4 7DE. tel 020 7498 6248, fax 020 7498 8447, email ccc@coralcay.demon.co.uk, website: http://www.coralcay.org

Coral Reef Alliance, 2014 Shattuck Avenue, Berkeley, California 94704 1117, USA, email info@coral.org website www.coral.org

Cousteau Society Inc, 870 Greenbrier Circle, Suite 402, Chesapeake, Virginia 23320, USA. email cousteau@cousteasociety.orgwebsite www.cousteausociety.org

Divers Alert Network (DAN Europe) P.O. Box DAN, 64026 Roseto (Te) ITALY> Tel: +39-085-893-0333, fax: +39-085-893-0050 fax, email: mail@daneurope.org, website: www.daveralert.org

Dive Rescue International, 201 North Link Lane, Fort Collins, Colorado 80524-2712, USA. Tel: (970) 482-0887, Fax: (970)482-0893, E-mail: Training@DiveRescueIntl.com, website http://www.diverescueintl.com/

Diving Diseases Research Centre, The Hyperbaric Medical Centre, Tamar Science Park, Derriford Road, Plymouth, Devon, PL6 8BQ, website www.ddrc.org

Global Coral Reef Monitoring Network, c/o Australian Institute of Marine, Science, PMB No 3, Townsville, MC 4810, Australia. website: www.coral.aoml.noaa.goc/gcrmn/

International Coral Reef Action Network (ICRAN), c/o UNEP World Conservaation Monitoring, Centre, 219 Huntingdon Road, Cambridge, CB3 0DL, tel: 01223 277 314, email kteleki@icran.org, website www.icran.org

International Association of Nitrox and Technical Divers (IANTD United Kingdom, Ltd.)
11 Telford Road, Ferdown Industrial Estates, Wimborne, Dorset, BH21 7QP
tel. 01202-893315, fFax: 01202-893316 Email: 100044.3401@compuserve.com, website: http://www.iantd.com

Irish Underwater Council, 78a Patrick Street, DUN LAOGHAIRE, Co Dublin, Eire.
website www.scubaireland.com

Marine Conservation Society, 9 Gloucester Road, ROSS-ON-WYE, Herefordshire, HR9 5BU, Tel: 01989 566 017, fax: 01989 567 815 email info@mcsuk.org website www.mcsuk.org

National Maritime Museum, Romney Road, Greenwich, London SE10 9NF
tel 020 8858 4422, website http://www.nmm.ac.uk

Nautical Archaeological Society, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth, Hampshire, PO4 9LD, Tel: 0123 9281 8419 ,
email NAS@nasportsmouth.org.uk website www.nasportsmouth.org.uk

PADI International Ltd, Unit 7, St Philips Central, Albert Road, Bristol, BS2 0PD. Tel: 0117 300 7234, fax: 0117 971 0400 email general@padi.co.uk website www.padi.com

Royal Air Force Sub-Aqua Association website: www.rafsaa.org

Reef Check Foundation, 1652 Hershey Hall, University of California at Los Angeles, Los Angeles, CA 90095-1496, USA. Tel 1-310-794-4985, fax 1-310-825-0758, email: Rcheck@UCLA.edu, website: http://www.reefcheck.org

Scottish Sub-Aqua Club, Cockburn Centre, 40 Bogmoor Place, GLASGOW, Lanarkshire, G51 4TQ, Tel: 0141 425 1021 , fax: 0141 425 1021 email ab@hqssac.demon.co.uk website www.scotsac.com

Society for Underwater Technology, 80 Coleman Street, LONDON, EC2R 5BJ. Tel: 020 7 382 2601, Fax 020 7 382 2684, Website www.sut.org.uk

Southampton Oceanography Centre, Waterfront Campus, University of Southampton, European Way, SOUTHAMPTON, SO14 3ZH, Tel: 023 8059 6666, fax: 023 8059 6667 email external-affairs@soc.soton.ac.ukwebsite www.soc.soton.ac.uk

Sub-Aqua Association, 26 Breckfield Road North, Liverpool, Merseyside, L5 4NH. Tel: 0151 287 1001, fax: 0151 287 1026, email admin@saa.org.uk website www.saa.org.uk

UK Diving: the UK Divers Internet resource. Website: http://www.ukdiving.co.uk/ukdiving.htm

UK Sports Diving Medical Committee. website www.uksdmc.co.uk

US National Association for Cave Diving website: www.safecavediving.com
E-mail: gm@safecavediving.org

US National Association of Underwater Instructors (NAUI). website www.naui.org

2

DIVING POLITICS

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2.1 INTRODUCTION

An expedition organiser in the 1980's, whether working in the UK. or abroad, unfortunately needs to take account of several legal and political factors. These include:

Personal accident insurance for all expedition members.

Third party insurance for the expedition corporately, and for all members individually.

Equipment loss and damage insurance.

Legal and political permission to dive in the country concerned at the desired place.

Legal and political permission to conduct the desired research.

Confirmation of suitable diving training and medical standards of all personnel, recognised by the country.

Confirmation that the equipment and diving methods used comply with the regulations in the country.

Confirmation that any Code of Practice used is acceptable in the country.

This list is somewhat daunting, and I do not want to suggest that a diving expedition should become bogged down in paperwork before it starts. Many of the issues listed above never arise, and in cases of doubt it is sometimes better to let sleeping dogs lie. If you are working closely with colleagues in another country which does not have legislation applying to diving, then it is best to rely on common sense, prudence, and normal good diving practice. However all the political and legal factors listed can arise, and you should at least have your answers ready. Your decisions need to be justifiable, and it is not convincing to say "I never thought of that".

The issue of insurance will not be dealt with in this article, although it has clear implications which could cause a lot of trouble if an accident happened abroad and insurance were inadequate. The other factors will be discussed briefly in order.

2.2 LEGAL AND POLITICAL PERMISSION TO DIVE AT THE DESIRED PLACE.

Most countries do not restrict diving in general, do not restrict sport diving, and do not restrict scientific diving. That is to say, it is not an offence against the law to dive using SCUBA equipment without political or regional permission. There are however many exceptions, and in some countries even the use of fins, mask and snorkel will arouse suspicion. Many Mediterranean countries require the diver to have a permit from the regional government or navy, and this is justified on the basis of controlling the safety of diving standards, and to limit archaeological souvenir-hunting. Countries with a military government tend to require permits because they suspect that diving relates to military matters or coastal defence. Coastal regions near borders, areas of military activity, near naval bases, submarine bases, exercise areas, etc., will usually be banned for diving.

In the early stages of planning an expedition you will almost certainly be in contact with nationals of the country you are visiting, and you can find out whether political permission to dive is required. This should be done very carefully so as not to invite unnecessary bureaucracy. The World Federation for Underwater Activities (CMAS) Year Book, published by the CMAS, 34 Rue du Colisee, Paris 75008, France, contains a review of the political requirements in many countries, but is now slightly out of date, and is probably not complete.

2.3 LEGAL AND POLITICAL PERMISSION TO CONDUCT THE REQUIRED RESEARCH.

This is an obligation which is general to all expeditions. Again, in most countries you can collect plants, rocks, etc., on land or in the water without breaking the law. However it is common sense and etiquette to inform your scientific colleagues in the country concerned of your intentions. Normal professional correspondence should alert you if there are regulations limiting the collection of protected species, disturbing protected parks or reserves, etc. Underwater the situation can be more complicated than on land. Again it is a question of when to let sleeping dogs lie. If you stir up too many doubts you will find that half a dozen government departments, Fisheries, Navy, Coastguards, Regional Government, Science, etc., will want to vet your request. It is best, as with all expeditions, to have the strong support of a local museum, university, or other institution, who will be familiar with the minimum bureaucratic requirements.

2.4 CONFIRMATION OF SUITABLE DIVING TRAINING AND MEDICAL STANDARDS FOR ALL PERSONNEL, RECOGNISED BY THE COUNTRY.

As of 1981 professional scientists who dive in the course of their work in Britain must comply with the Health and Safety at Work Diving Regulations, and with its Exemptions for Scientific Diving up to August 1986. The minimum standard of training is the BSAC Advanced Diver or HSE Part IV qualification. The diver must also pass the annual medical examination by a doctor approved by the Employment Medical Advisory Service. Divers who are not employed, and are not gaining a living as self-employed divers can take part in scientific activities as volunteers with the usual standards of sports diving training and medical. All diving activities in which at least one diver is subject to the HSE Regulations must be conducted according to the Regulations.

The Exemptions from certain clauses of the HSE Regulations are subject to the diver adhering to the Code of Practice for Scientific Diving published by the Underwater Association for Scientific Research and the Natural Environment Research Council.

When a British expedition goes abroad it is not reasonable to say that the standards of safety can be lowered because the HSE Regulations and Code of Practice do not apply. At the lowest level of moral judgement, that would look very bad in a court of law in the event of a serious accident.

An expedition consisting entirely of undergraduate students and unpaid volunteers, none of whom was earning income from the expedition, would be exempt from the HSE Regulations whether they were in the UK. or not. They would however be very strongly advised to adhere most strictly to the standards of the Code of Practice for Scientific Diving. This permits the dive organisers to develop unique sets of diving rules and procedures to cope with exceptional environments. The underwater Association can also arrange expedition third-party insurance is notified in advance.

An expedition of which one diving member, or more, was a working professional scientist drawing a salary during the time of the expedition would be strictly subject to the HSE Regulations within the UK; would be strictly liable to the Merchant Shipping Division Regulations if working from a British registered vessel; and would be very strongly advised to the HSE Regulations and Exemptions whatever country they were working in. If the working scientist(s) chose to take unpaid leave during the period of the expedition, they would be technically outside the application of the HSE Regulations even if in the UK.. Again, legal and ethical considerations suggest that this loophole should not be exploited flagrantly. The diving practices permitted and required by the HSE are not unreasonable, even if the wording could be a great deal clearer.

The discussion so far sets the minimum standard of training, safety, and medical requirements which are acceptable whether in UK or abroad. The problem arises when you travel with these standards to a country which has existing diving legislation and of different standards.

For diving training, the CMAS issues training certificates known as Brevets, which allow you to determine the equivalence of training standards in sports diving. The CMAS Scientific Committee recommends that all scientific divers should be trained to the standard of a CMAS-3-star (which is equivalent to the BSAC Advanced Diver). If the divers are employed, they are recommended to obtain the CMAS Scientific Diver Brevet, which certifies that they hold the CMAS-3-star qualification, and are permitted legally to dive at work in their country of origin. Even if the divers from two or more countries do not actually possess the CMAS Brevets, you should be able to establish the equivalent levels of the various national training certificates.

For medical standards, there is a CMAS medical certificate form, which is oriented to sports diving. The European Diving Technology Committee (EDTC) also publishes an international standard, but it is oriented towards bell diving and saturation diving. CMAS has recently been commissioned by UNESCO to produce an International Code of Practice for Scientific Diving, which will contain a medical standard definition.

2.5 CONFIRMATION THAT EQUIPMENT AND DIVING METHODS USED COMPLY WITH DIVING REGULATIONS IN THE COUNTRY

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For diving practice itself there are not yet any published, complete, international standards. The EDTC (1986) has published a very broad description of safe standards in industrial diving, but there is almost no mention of SCUBA diving in this document. It is mentioned from time to time as "surface oriented diving" but the practices described or permitted do not add up to a complete and safe set of standards. Several Codes of Practice exist in different countries, (UK, USA, Canada, South Africa, Germany, Italy, Australia), with many common factors, but they are not identical, (Flemming 1985). The CMAS-

UNESCO Code is the first truly international document trying to define a safe range of diving practices for all countries and all conditions.

If your team is going to work as a closed unit without involving divers of the host country, and without directly involving their institutions or ships, it is probably best to adhere to British, BSAC, Underwater Association and HSE standards. If the country concerned, eg., USA, Germany, or Australia, has a highly developed set of domestic regulations, it would be wise to check that the British standards do not contradict the local regulations in a major way which could cause trouble. The most likely points of divergence would be maximum diving depth on compressed air, maximum decompression permitted in the water, and requirement for an on-site recompression chamber. For a review of different practices on these and other matters, see Flemming (1985). In most circumstances there is no infringement of local regulations, whilst remaining within British regulations.

If you are working jointly with scientists or students of the host country, further adaptations maybe needed. Firstly, you may agree that all diving will be conducted according to one set of national practices or the other. It is advisable to exchange diving manuals. Codes of Practice, etc., in advance so that the chief divers on each side can see if there are any problems. If one document is agreed upon, then all the divers should be provided with copies in advance so that they can familiarise themselves with any changes of practice, signals, etc., which they may have to learn.

If it is not possibly to compromise on any existing document, whether national or international, than the leaders of the diving teams from different countries must draw up any additional or substitute rules which are necessary to allow the whole team to work coherently.

2.6 CONFIRMATION THAT ANY CODE OF PRACTICE USED IS ACCEPTABLE IN THE COUNTRY.

Codes of Practice have been referred to above, and are listed in the bibliography. Whether your team is self-contained, or whether you will be working with divers from the host country, it is advisable to obtain the national Code of Practice for Scientific Diving, and learn about local standards. This may be useful as much for information about local environmental conditions and dangers, as for legal points. Some Codes contain recommendations for methods of recognising foreign diving groups.

If the Code you intend to use is very close to the national Code of the host country, and if you are working as a self-contained group, it is probably best to stick to your own rules. If there are radical differences, then you may have to adapt your rules slightly, or negotiate with your host diving group. Remember that the rules used locally may be based on very sound limits dictated by environmental conditions with which you are not familiar.

2.7 CONCLUSIONS

Thirty years ago these matters were handled on a basis of common sense and practical experience. Now that diving has evolved so far, and there are so many scientific divers, legislation, rules, and Codes dictate many of our choices. Most of the documents, especially the Codes of Practice, allow very considerable initiative and judgement to the Chief diver, and it is essential that expedition leaders read these documents, and decide where they have to abide strictly by laws and rules, and where they are free to make their own judgement. Your expeditions will be better for it.

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3

THE LOGISTICS OF DIVING EXPEDITIONS

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3.1 THE EXPEDITION BASE

Research done, and the bulk of the administration in hand, more time can be spent on what is going to happen in the field. One of the first and most important choices is that of where the expedition base will be. There are several basic possibilities.

3.1.1. To use existing accommodation and facilities provided by local research diving organisations. This tends, generally for entirely ridiculous reasons, to be frowned on by certain quarters of the "expedition world", to whom a project is not an expedition unless it has a "boy scout" element to it. If you are going half-way round the world to undertake a perfectly respectable underwater project and happen to find a simple field station which has boats, diving equipment and a lot of local expertise at a not too expensive price, it makes sense to use it as your base and save yourself a lot of work. We did that on the first Blue Holes expedition, and it proved a blessing in disguise, not the least because our freight was held up in the UK., and most of our diving gear with it. This doesn't mean I advocate hotel accommodation and straightforward commercial hire of gear; there are often good reasons for remaining independent of local organisations, and having all your own facilities. But look to see what is available in your chosen field area, and use local facilities sensibly where they are available. Serious expeditions have not got to justify their existence by playing soldiers in the field.

3.1.2. To establish your own camp. More often than not, this is the necessary solution. Tropical islands are often poor on low budget accommodation, or cannot support the presence of an expedition which is entirely dependant on the local community for supplies and subsistence. Nor are polar regions, nor some of the more remote areas of the world to which diving expeditions are attracted. In this case, be prepared to take everything; equipment, food, tents and toilets, boats and engines, insect repellent, the lot.

3.1.3. To find a compromise between the above, it is often possible, once initial contact has been made, to borrow or rent hard accommodation, (ie, something with solid roof and walls) which can function as expedition base. In some areas, planning the expedition for school holiday time (which often corresponds with university or summer vacations at home) means that the local schoolhouse is free. Try bartering accommodation for lectures and slideshows, or educational days with the local children. Contact local government officials (after first clearing it at national level), but be wary of trying to do things directly through central government. Sometimes they can promise the earth, but local availability might not match up to central expectations.

3.1.4. To use a hard boat. often, for a small and mobile expedition, this is the best bet. Though outright hire can be very expensive, there are sometimes local divers, fishermen, research institutes etc, which can come to an arrangement over availability and price. If you are really lucky, you may be able to borrow one. for fuel costs alone, though such chances are rare.

3.2 CHOICE OF SITE

Most expeditions end up on shore, making the best of a general compromise between one or more of the types of base outlined above. If this must be the case, there are certain things to look for in your choice of site.

3.2.1. It must be large enough to accommodate all your requirements. People living entirely on top of each other, at both work and rest, can soon fall out over the most trivial of differences . . . and some of the differences of such close contact may not be trivial! Try telling the photographer, who just found sand in his stripped down cameras, that the diving or scientific equipment just HAD to be washed off in the only sink at the same time. Make sure there will be enough space for everybody on the team to have their own territory, divers, scientists and camp organisers alike. Plan the layout so that conflicting interests are kept apart (i.e. don't site the compressors next to the darkroom, or the lab space next to the kitchen).

3.2.2. It should have good access to both sea and land, and ideally to local communications centres for emergencies. If there is no nearby 'phone or radio, make sure you have your own links with the outside world in case anything serious goes wrong.

3.2.3. It ought to be in a healthy location. Avoid swamps (and therefore at least some mosquitoes), the beach itself (and hence sandflies, storms, etc.) and local pollution. It should have a good-quality and dependable freshwater supply.

3.2.4. It should not be in a position to annoy or overtly disturb the local inhabitants. Compressors and generators running night and day are bad news for local community relations.

3.2.5. If boats are being kept at sea, it should have a sheltered anchorage nearby, or provision to get boats out of the water in very bad weather.

3.2.6. Security should be reasonable. Diving and scientific equipment is expensive, and can be a real temptation to locals, both adult and juvenile. Don't just regard security as keeping people out, think of the temptations to a third world community and play fair. If you are using someone's house, a school, or other local hard accommodation, treat it with respect, and try to keep dirty, wet or soiled equipment out of it.

3.3 CATERING

Give someone the responsibility for catering (even if everyone will be taking turns at cooking in the field) and make that individual research (1). Do not feel that everything has to be taken with you; often for small expeditions it can be easier and more cost effective to buy in the field country, and take out to the field site. Local produce can be obtained, generally at reasonable prices with a bit of honest barter, but beware of trying to add too much to the larder through your own efforts. Locals in coastal areas fish for their livelihood, which is often a precarious one, and it is offensive to them to see you bringing large catches back for expedition consumption. In many areas, it is illegal for non-residents to take any marine creature for food, so check first whether taking the odd fish is even permissible legally. Whatever you do, do not take any fish, lobster or shellfish on SCUBA. It goes against every conservation law in the book, and sets a thoroughly negative example to locals. With luck, they'll shop you. However, don't feel duty bound to subsidise the local economy if you can't afford to. Buy your food where your budget best allows.

Do remember that strenuous diving activity creates a hearty appetite, and plan accordingly. On larger expeditions, take a cook. If you plan on spending long periods of time in an open boat, drinks and high energy snacks are worth taking with you. If the work is unduly monotonous, which much expedition research work is, the lunchtime break can be one of the high points of the day . . . make it a morale booster.

Finally, if you are working somewhere remote enough for it to be essential and acceptable to catch food from the sea, make sure you know what local fish are safe to eat. Some of the more succulent looking can be quite poisonous.

3.4 TRANSPORT

Chances are that you are going to need both land and sea transport. This could be one of your biggest problems. Unless you are absolutely guaranteed boats in the field, take your own. This usually means an inflatable, and for inshore work, there is frankly little to surpass them for ease and convenience of use in remote locations. You will need to ensure that you have adequate repair facilities, and that the engines you will be using are up to the job, and that their shaft length matches the transom of the boat. Find out which engines are most commonly used in your expedition area, and where the local agents are. Usually, 35 or 40 hp outboards are the most reliable, there are few inflatables that really warrant anything bigger. Ensure there is a dependable supply of petrol available, and be prepared for the fact that petrol in remote areas may not be of the quality you are used to at home. Be prepared to (and trained to) decoke your engines at regular intervals, and take lots of spares. Outboard engines are notorious for being unreliable! Make sure that those team members who will be handling boats have had experience with the boat and engine types before leaving home, if possible, or alternatively allocate time in the first few days for such training experience to take place. Learning to "read" new waters takes a while.

Land transport will probably be required for a variety of reasons; going shopping, lowing boats to distant sites, as emergency transport, for servicing the expedition needs (eg, carrying petrol, equipment for shore dives, collecting equipment, etc). Type of vehicle may depend on local availability (I've had everything from Cadillac to rubbish truck), and should be sorted out before you get into the field. The ideal expedition vehicle is probably a four-wheel drive pick-up; anything with a closed top is immediately restricted on carrying space. A trailer is invaluable, and it is quite possible to adapt a good boat trailer to serve as an equipment/luggage trailer also. Make sure that whatever vehicle or trailer you use is robust enough to cope with local conditions, and expedition drivers. A mechanic is invaluable on diving expeditions, and should be adaptable enough to cope with everything from outboards and compressors to car engines.

One thing easily forgotten in organising diving expeditions is just how valuable aerial survey can be. A short flight over the field area is a small plane with a camera and map can be invaluable in choosing dive sites. Microlites have possibilities, but are expensive and difficult to fly in field conditions, even if fitted with floats. Often, though, it is worth the expense or time spent in arranging an aerial overview of the area, when set against the time and fuel expended in searching from the sea.

Chartering a vessel has attendant problems as well. In many tropical countries, there are specialist dive charter boats which have all the facilities demanded of an expedition base. These are invariably expensive, and often not really geared up to the concept of expedition diving as against holiday diving. Make sure your charter captain understands exactly what he is letting himself and his boat in for, and be prepared to take his views into account at any time.

Whatever your chosen form of transport, make sure you have enough of it. Do not get into the situation where you have too many people or projects for too few boats or vehicles, and do not rely on only one boat or one engine, whatever your situation. If you do, there will be days when you can't work, because something is broken.

When considering boats, it is also essential to consider safety equipment on board. ABLJ's (BC's to Americans) will serve as life jackets, but some form of (waterproof) communication is desirable, as are emergency items like flares, first aid, paddles and tool kit. Think of what might go wrong at sea on your expedition, and make sure it is planned for in the boat equipment.

3.5 ORGANISATION OF DIVING

Depending on the size, experience and abilities of your expedition divers, you will need to have some form of control over the diving practices on the expedition.

On a very small expedition composed of highly-experienced divers used to working together, this can be minimal. Such divers will be aware of their own limitations, and of the potential mishaps and consequences of their underwater work.

Amongst less experienced personnel, the opposite can be true, and a very structured set of rules should be set down and adhered to. A general guideline are the rules of organisations such as BSAC, the Sub-Aqua Association (SAA), PADI, or other diving training organisations. The World Underwater Federation (CMAS) and the Underwater Association both publish Guides for Scientific Divers (3,4), and these should be referred to during the pre-expedition organisation, when the expedition diving guidelines should be established.

It may be felt advisable to appoint a Diving Officer to co-ordinate diving operations and to take charge of equipment. It should be remembered that expeditions are notoriously anarchic in composition, and such authority should be based on respect or common- sense, rather than a militaristic regime that does not allow for changing levels of experience in the field, or which cannot adapt to changing circumstances or situations. Blind obedience to club standards or rigid rules can have a distinctly negative effect on divers who, often quite rightly, consider that rules made for inexperienced sports divers have a restricted relevance to experienced divers in an expedition situation. There must, however, be a degree of experience of the diving personnel, the availability of emergency facilities and any other variable which local condition or regulations produce.

It is not a bad idea for each diver to spend a couple of minutes each day filling in a logbook of the day's dive. A page of the Underwater Association logbook is given as an example of a typical layout (see Figure I on page 22). This serves several functions; it acts as a personal record for the diver's own use, it provides information that may prove essential for medical reasons (eg. if the diver develops decompression sickness), it provides accessible information on the expedition's diving activities, and it encourages each diver to record his work.

If a Diving Officer is appointed, part of his or her responsibility should be to ensure that he or she is thoroughly familiar with the local marine and coastal hazards that expedition divers might encounter. He or she should also be familiar (and should ensure that other members are familiar) with the procedures for dealing with diving incidents, such as decompression sickness, and are aware of the evacuation routes to the nearest appropriate medical facility.

Decompression diving on expeditions should be undertaken with extreme care. There is no reason, should the project demand it and the divers are experienced in such procedures, that decompression diving should not take place. Obviously, the degree of such diving, and the personnel involved, should take into account the availability of appropriate decompression facilities. It is unlikely that these will be available on site, and it may be a considerable distance to the nearest chamber, especially in third world countries. Expeditions undertaking decompression diving in extremely remote locations should seriously consider taking a two-man chamber with them (together with a qualified medical and chamber staff) and all expeditions undertaking such deep diving should have oxygen and the appropriate medical equipment on site to treat decompression incidents en route to a recompression facility. Decompression tablets should be standardised, and those should be familiar to the divers involved (eg. BSAC/RN or US Navy). Decompression meters such as the SOS meter or Divetronic can be used, but only by experienced personnel. Waterproof printed tables should always be available in the water on each dive.

3.6 REFERENCES

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4

EQUIPMENT FOR UNDERWATER EXPEDITIONS

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4.1 OBTAINING EQUIPMENT

There are two ways to approach equipping an underwater expedition. The first is to obtain completely new equipment for everyone, the second to compromise and expect each member to take their own, adding to this as and when necessary. Each, as we will see, has its pitfalls.

4.1.1. Equipping from scratch.

The main advantage of this is that equipment can be standardised (ie, all regulators are the same, all ABLJ's the same) and therefore all spare parts will fit each individuals equipment. This makes maintenance easier, and allows equipment to be interchanged without having to re-familiarise the diver with subtle differences in style and technique. It is also likely to be extremely expensive. The diving equipment world is a relatively small and specialised one, and outright sponsorship, even for large expeditions, is unusual. Even if a manufacturer can be found who is prepared to sponsor a project, this will usually be in the form of some discount, rather than outright donation.

4.1.2 Using your own equipment.

This has the advantage of cheapness, existing familiarity and immediate availability. It has the disadvantage of already being used, and therefore possibly more likely to malfunction (though this does not necessarily differ with new gear), of necessitating a wider range of spare parts, and a wider range of experience in servicing techniques. If each member is providing their own equipment, it must be made clear that they are responsible for the obtaining of a full range of spare parts for it, and for basic field servicing. More detailed servicing should be the responsibility of one individual, who should be well trained in the servicing of diving equipment.

It should be possible to compromise if the expedition requires more equipment than the team members possess. An arrangement can be made with a sponsoring company to purchase a certain amount of equipment in addition to the member's own equipment, but it should be remembered that, when taking photographs, the sponsor's equipment should be given a certain priority.

4.2 TRANSPORTING EQUIPMENT

Getting equipment into the field can be a problem. Airlines are often reluctant to take large items such as compressors or generators which may have fuel traces in their tanks (even for payment) and air freight charges can be prohibitive. Air cylinders transported by air must be completely empty, and should have their valves removed (it is a good idea to plug the hole securely and hang a small bag of silica gel inside - which should, of course, be removed before using at the other end!)

Diving equipment, by its nature, tends to be on the heavy side! Moving expedition equipment overseas generally means freighting it by sea, well in advance of the main team. It should be met at the far end by either a fully- briefed team member, or local representation with all necessary documentation, and a certain time allowance should be made for getting it through customs. Negotiations beforehand with the relevant authorities can sometimes get it classed as scientific supplies, which often can be imported free of duty. It is worth reading up on freighting procedures, and making yourself closely acquainted with the customs regulations regarding the import and export of scientific and diving equipment in your host country. Don't forget to obtain a stamped statement of exportation from British customs for you gear before you leave. Personal equipment may be fine, but if you are taking large, sophisticated items abroad, you may have trouble bringing them back in without relevant documentation. If you are taking items out by air as hand baggage which need customs documents, leave plenty of time to get the paperwork stamped up at the airport. It can take several hours. Your documents will also need to be on letterheaded paper, to persuade the customs people it is official. Give the responsibility for freight and customs to someone reliable in your team, and work closely with them. Send them out ahead of the main team, so that the equipment will be waiting for you (with luck) on arrival.

Do take basic gear (mask, snorkel, fins) out with you. A lot can be done with that alone if there is a hold-up with freight.

4.3 TAKING EQUIPMENT BY AIR

When taking any pressure proof diving equipment by air, it is important to remove O-rings, undo pressure compensating screws, or place the gear in pressure-proof containers, items such as depth gauges, decompression meters, torches and cameras can be damaged by the effects of reverse pressure.

4.4 WHAT EQUIPMENT TO TAKE

Never rely on being able to obtain everything in the field. Even if you have a prior hire or purchase arrangement, take your own mask, snorkel and fins with you, then at least you know they fit. It is a good idea to take your own regulator, or a regulator which you know is well-serviced and reliable.

4.5 WETSUITS OR DRYSUITS

Think about where you will be diving. How warm is the water? How long will you be in it? What sort of environment will you be working in? These and other local factors determine the best gear to wear.

If you are going to be spending long periods of time in the water, then you will get cold, even in the tropics. Anywhere where water temperature is below body heat, your body will lose heat when in it, by simple thermal conduction. Wear at least a shortie wetsuit, and move to a full one-piece or two-piece if you think you will be in the water (even snorkelling) for more than two hours at a stretch.

Other factors to consider in tropical waters are the possibility of sunburn (cover up even if you are only in the water for short bursts of time), abrasion injuries from coral, etc. or injuries from marine life : from hydroid stings to stonefish. Some form of protection from these is necessary, and a full 3mm wetsuit is recommended for all serious underwater expedition work, as a minimal covering. Hard-soled bootees or sandshoes give added protection when walking on the seabed. Bare feet are asking for trouble!

If the water is likely to be cold, in temperate or polar conditions, then either an extremely good and thick wetsuit, made-to-measure, or some form of drysuit is advisable. Undoubtedly the warmest wear is the "Unisuit" - type of drysuit with a good thermal suit underneath (high quality fibrepile or thinsulate). These allow underwater stays of an hour or more, even in the coldest conditions an amateur expedition is likely to encounter, but can be very restrictive on movement. Membrane-type suits (eg. Viking, Typhoon, etc.) have no thermal insulation value unless worn over really good quality undersuits. A layer principle is best: Damart or similar underwear as a bottom layer, one or more layers of insulating clothing on top, then the suit on top of that, the number and thickness of layers depending on the temperature. Dry gloves can be used in the coldest of conditions, it is worth taking advice from divers who have worked in your particular field area before even British Antarctic Survey divers sometimes prefer to use thick high quality wetsuits as opposed to drysuits. Other divers who spend a long time in tropical waters occasionally prefer to use drysuits. Whichever suits you best, a good hood is invaluable: heat loss through the head can be a real and uncomfortable problem.

Such items as masks, snorkels and fins are largely best left to individual preference. Use those which you feel most comfortable in the water with. And DO make a point of familiarising yourselves with new equipment BEFORE you leave home. It is too late to find out it does not work, or doesn't fit, in the field.

4.6 TANKS AND COMPRESSORS

These can be the bane of many amateur expeditions, being the more expensive items of equipment to obtain, and some of the heaviest to transport. The ideal air tank for most expedition purposes is the 80 cu ft aluminium Luxfer type, as used by most professional diving centres and resorts. Smaller ones need charging more regularly, and do not last as long in the water, though occasionally they have a particular function. Larger capacity tanks, though again useful for particular types of diving, weigh a lot more and are often difficult to obtain.

Tanks can be ferried out by air if absolutely essential (though with the qualifications mentioned earlier) or freighted out in advance. They can be bought out in the field, and possibly resold, though prior ordering and resale arrangements are recommended (the local diving club might be able to help with this, but do not expect to gain money, or even to break even). Whichever method you use to obtain them, remember they are one of the most essential items of your expedition, and their availability must be guaranteed BEFORE you get into the field.

Compressors have given me more trouble than any other item of equipment. The best thing you can do is buy a new one, or a professionally-reconditioned one, and freight it out in a solid box with "This side up" in big 3-D letters. Bribe someone to take care of it en route. Doing anything else leaves you open for a lot of headaches and grief in the field, believe me!

Failing that, make sure well in advance that the compressor you are borrowing is serviced before you use it (ideally professionally), that it is packed for travel (oil and fuel drained, etc.) and that you both have spares and are trained to fit them. Know where to obtain spares from in the field, or have an air-freighting arrangement with someone at home. Take spark plugs, several fan-belts, compressor and engine oil, spare filters and fixing bolts and anything else you think might conceivably fail. Then get a second compressor, ideally the same model, and take it too. One is sure to break down.

In the field, make sure that both engine and compressor oil is checked before each use, that the fan-belt is kept at the right tension, and that all nuts and bolts are screwed down correctly. Change the filters at the recommended intervals, and keep an accurate log-book of use, so that engine oil can be changed at the correct running intervals. Give the responsibility of servicing it properly to one or two definite individuals, do not let unqualified people tinker with it. The compressor is quite literally the heart of a diving expedition, without it, the diving dies. Keep it somewhere safe, not too near people, because it is loud and disturbing, but under shelter. Keep the tanks you fill under shelter too, full air- tanks left out uncovered under a hot tropical sun is a recipe for trouble.

4.7 DEPTH GAUGES

A word or two about depth gauges. If you are undertaking any scientific, or survey work, or undertaking any deep diving, these need to be calibrated for accuracy, and tested before you leave. Get reliable, robust ones, make sure that they are accurate, and either take them out in a pressurised container, or get ones that can be adjusted for air travel. Some depth gauges, and decompression meters, can be adversely affected by the reverse pressure of air flights, even in pressurised cabins, and will henceforth read inaccurately. Your life (and the accuracy of your results) may depend on this.

4.8 MAINTENANCE

Wherever it is used, and however it is used, equipment is only ever as good as its maintenance allows. Look after all your equipment, personal and team, in the best possible way you can. Try and get into the habit of seeing diving gear cleaned and put out to dry as soon as you return to base. Get a hose pipe if water is in plentiful supply, or an old oil drum, bath or bucket if not, and give all salt- water covered gear a good fresh water soaking. This applies to camera gear, scientific or specialist gear (if waterproof) as well as diving equipment. Rinse wetsuits regularly.

Make a point of stripping down basic equipment and checking its condition on a regular basis. Use silicon grease on O-rings, powder drysuit cuffs with talc, use beeswax on drysuits zips, silicon spray or grease on other zips. Check the condition of fin and mask straps. Mend rips and holes in suits before they become a bigger problem. Check regulator hoses. Look after your gear!

Such maintenance goes for outboard engines, boats, compressors and everything else, it is the job of the leader to make sure that whoever has the job of maintaining these is doing so satisfactorily. If a boat is taking in water, make sure there is no leak. If an engine is not running smoothly, ask why not.

It is all too easy under harsh field conditions to let maintenance slide. It must be done, however tired or hungry you are. Put it off, and it will get forgotten.

Make sure that you take a comprehensive tool kit, repair kits for boats and equipment, spare parts for machinery and diving gear, and any special tools that may be needed to maintain specialist equipment (boat engines, regulators, cameras, etc.).

4.9 SPARES AND TOOLS

A basic spares kit for field maintenance should include the following items:

Waterproof container (for keeping them in)
Spare straps for mask, fins, knives, gauges, etc.
Spare 0-rings for all equipment, several of each (remember the obscure ones, like the swivel rings on contents gauges)
Blanking off caps for first stages.
Silicon grease.
Neoprene cement.
Drysuit cuff instant repair kit.
Large needle and strong nylon thread.
Blow-discs for US air tanks.
Jeweller's screwdriver kit (standard and Phillips)
Small sharp-nosed pliers
Small wire-snap
Adjustable spanner
Small mole-grips
Screwdrivers (normal size, standard and Phillips)
Old toothbrush
Sandpaper
Nylon tie-wraps
Roll of duct tape (this has held many an underwater expedition together!)
WD-40 or similar

Spares and Tools (continued)

Small socket set/spanner set to suit equipment (ie, metric or AF etc.)
Small selection of relevant stainless steel nuts, bolts, split pins.
Alien keys.
Junior hacksaw plus spare blades.
Knife, and nylon cord
Spare torch bulbs.
Superglue, araldite, Aquaseal.
Lighter (rather than matches).
Cyalume.

This kit can be expanded to suit environment and situation.

4.10 REFERENCES

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5

PRACTICAL ASPECTS OF UNDERWATER STILLS PHOTOGRAPHY ON EXPEDITIONS

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5.1 INTRODUCTION

It is not the purpose of these notes to provide the reader with a comprehensive course on the theory, general techniques, and equipment used for underwater photography. These topics have already been adequately covered in the various publications listed in the bibliography of this paper. These notes are intended as a practical guide which will enable the budding underwater expedition photographer to avoid the pitfalls encountered during the pre-expedition, expedition and post-expedition phases.

5.2 VALUE OF UNDERWATER PHOTOGRAPHY

There are few projects undertaken underwater in which it is not important to have a permanent visual record, be they related to the natural sciences, archaeology or recent history. Photographs of sites and habitats will set the scene and often obviate the need for lengthy word "pictures" (Figure 1). Photographs can be studied in detail sometime after the fieldwork and considerably more information gleaned about the environment from them. This is especially true as far as the positional relationship of plants and animals to each other and to the environment is concerned. Detailed photographs which record the size, shape and colour of living organisms can be extremely useful to aquatic biologists seeking features which will enable them to identify organisms they have seen, and which, in the preserved state, are often of a size, shape and colour which bears little relationship to that of the living organism (Figures 2 and 3). In addition, underwater photography is important to the biologist seeking to convey to others the behaviour of animals (Figures 4 and 5), and to the archaeologist wishing to record the spatial relationships of artifacts before they are disturbed irrevocably.

Expedition reports, scientific papers, and lectures given after completion of the fieldwork, benefit greatly from the use of good photographs, particularly if they add the dimension of colour. Many of those reading the reports or attending lectures will not be familiar with the equipment and recording and sampling methods used underwater and it is thus well worth photographing "divers at work" for a lay audience (Figures 6 and 7).

5.3 PRE-EXPEDITION PHASE

5.3.1 Early Planning

The underwater photographer asked to take part in a lengthy expedition to a remote area should meet the other team members at an early stage, for there is little point on going on such a trip with those who are unsympathetic to the photographer's aims, or with those whose manner and habits are irritating to him/her.

It is not often the case that underwater photography is the main objective of a diving expedition to a remote area of the UK or abroad, and thus the thought given to the needs of underwater photography are often low down on the list of priorities. This is probably because several expedition members will have their own underwater cameras, have dabbled in underwater photography, and feel that, at a pinch, they could cover this aspect of the expedition adequately amongst themselves if and when time permits. This is a great error, and in every proposed expedition with more than two or three members, one of the team should be designated as the (or main) underwater photographer and the others (even the expedition leader) must be prepared to defer to that person in underwater photographic matters. If the person approached to do the underwater camera work cannot get these assurances at the early planning stage, then he/she is well advised to turn down the offer, no matter how attractive it may appear on the surface.

It is important, at this early stage, to ensure that the duties of the photographer and the photographic objectives are clearly defined, and that ownership of the resulting photographs is beyond dispute. If the copyright of photographs is to belong to the "Expedition organisers" then, of course, they, rather than the photographer, should pay for the film, although the choice of film stock should rest firmly with the photographer. In this case those seeking sponsors on behalf of the expedition should obtain the advice of the photographer as to which film stock is preferred before approaching film manufacturers.

Similarly, if photographic equipment is to be purchased, hired, or given by a sponsor then the views of the photographer are most important, for it is he who will have to use the equipment, and he who is ultimately responsible for obtaining satisfactory results, even in the most demanding conditions. In these circumstances the experienced photographer will invariably resort to equipment which has a proven reliability record and with which he is most familiar. If the financial base of the expedition is sound, it may well be wise to "hire" the photographer's own equipment for the duration of the expedition.

5.3.2 Later Planning

Having ensured that the photographic objectives are clear, the photographer should then set about determining what he can about the environmental conditions under which he will be expected to operate. It would ease his problems of choice of equipment if he were to have some idea of such physical conditions as air and water temperature, roughness of surface waters, likely underwater visibility, whether fierce currents are to be expected, and the depth range over which photographs are required. Ease of access to the water and whether or not there will be an experienced diver to assist with the underwater photographic tasks are also important considerations.

5.3.3 Buying Film

The amount of film the photographer takes with him on an expedition, is influenced by a number of factors, not the least being the duration of the trip, and the number of dives expected per day. In .warm tropical conditions it is reasonable to suppose that more time will be spent in the water (assuming that one is not continually engaged in deep diving) and that consequently more film will be used than in cold temperate or polar waters. When calculating the number of films that may be required one should allow for at least 2 films per dive if 36-exposure 35 mm stock is being used, and proportionally more if larger format cameras are being used with a smaller number of exposures per roll. In any event, it is wise to always procure more film than it is thought will be needed as the excess can always be sold off on return from the expedition.

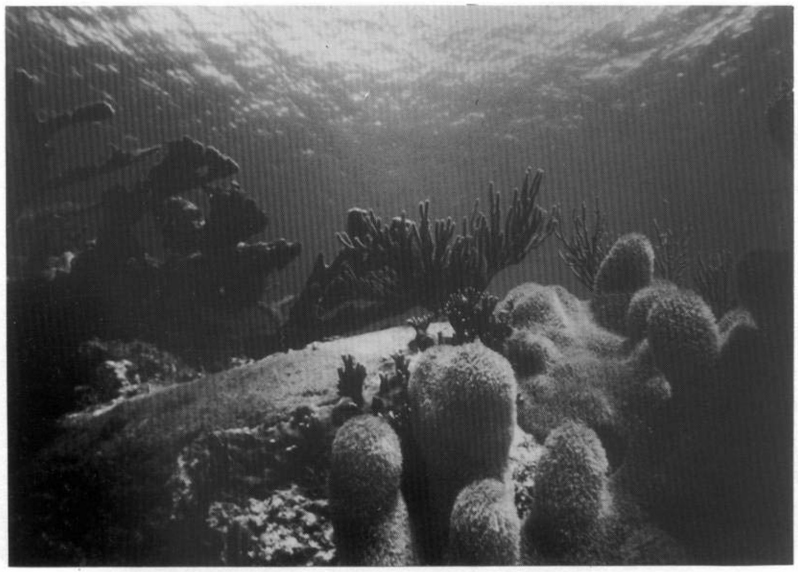

Figure 1 A coral reef scene photographed in natural light with fill-in flash on the foreground, using a Nikonos lens. Caribbean.

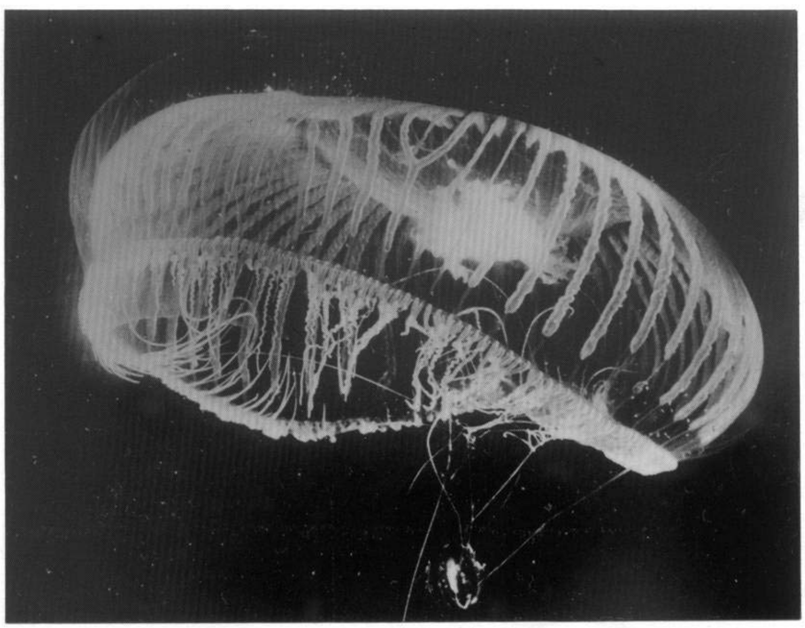

Figure 2 A fragile plantonic medusa photographed using a Nikonos +35mm lens with push fit Nikonos close-up lens, distancing bar and field frame. The subject was illuminated by flash from one side and slightly behind in order to show its internal structure. South West Ireland.

Since the advent of large photographic discount stores the financial advantage that used to be gained by buying film direct from the manufacturer has been largely lost. It is suggested therefore, that, unless film is donated by manufacturers, non-professional film is purchased in bulk from a large discount store. Prior to the trip (and on the trip if possible) film should be stored in a refrigerator to prevent any possibility of deterioration prior to its exposure underwater (see also Travel to Site).

It is always wise to use one's favourite slow-medium, high contrast, fine-grain film (K.64 in my case) as the main film stock, and not to resort to other types of film unless there has been ample opportunity to test them thoroughly under a range of conditions before leaving. If scenic work is likely to be consistently required in low light conditions, then medium-fast films will have to be purchased in sufficient quantity to cope with the possible need.

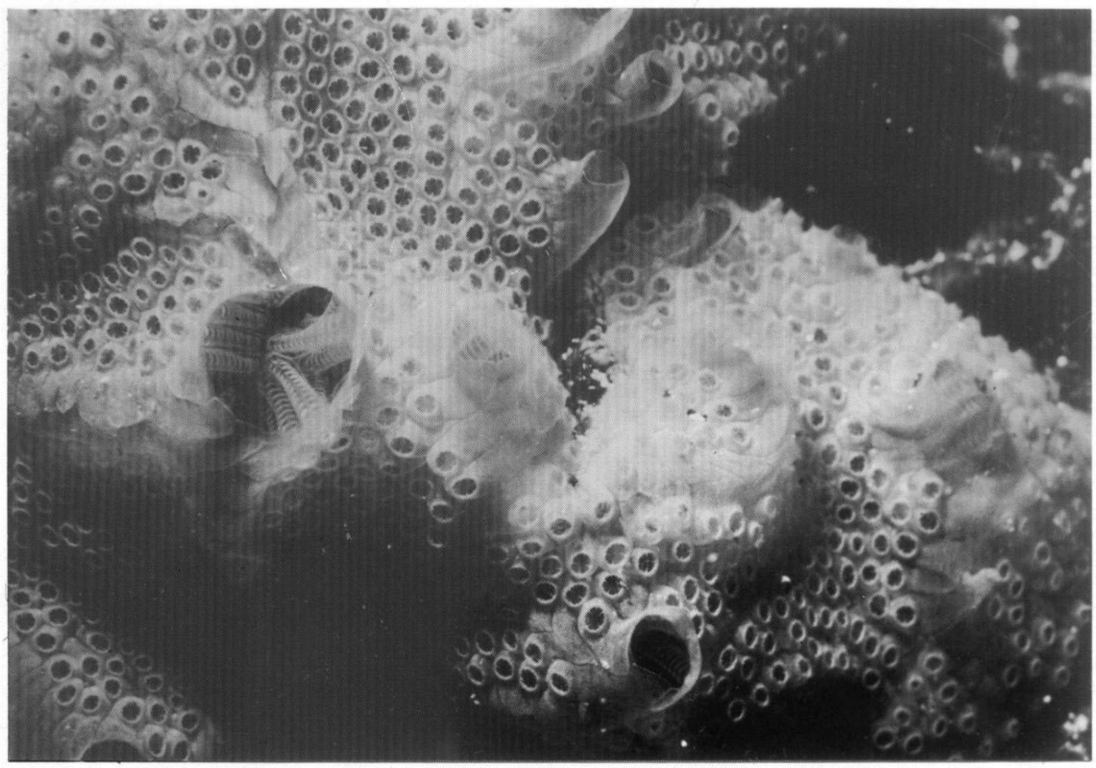

Figure 3 An expanded colony of sea squirts photographed using flash with Nikonos 35mm lens and an extension tube (1:1). Red Sea.

Although I would venture to suggest that on the whole it is a considerable waste of time (and sometimes unnecessarily risky) to develop film routinely on site, there is a need occasionally to process a film to check that the cameras are continuing to function correctly. This will mean that those photographers who normally use process-paid films such as Kodachrome will need to purchase an additional few rolls of film requiring E6 development. These can then be processed in the field using E6 processing chemicals.

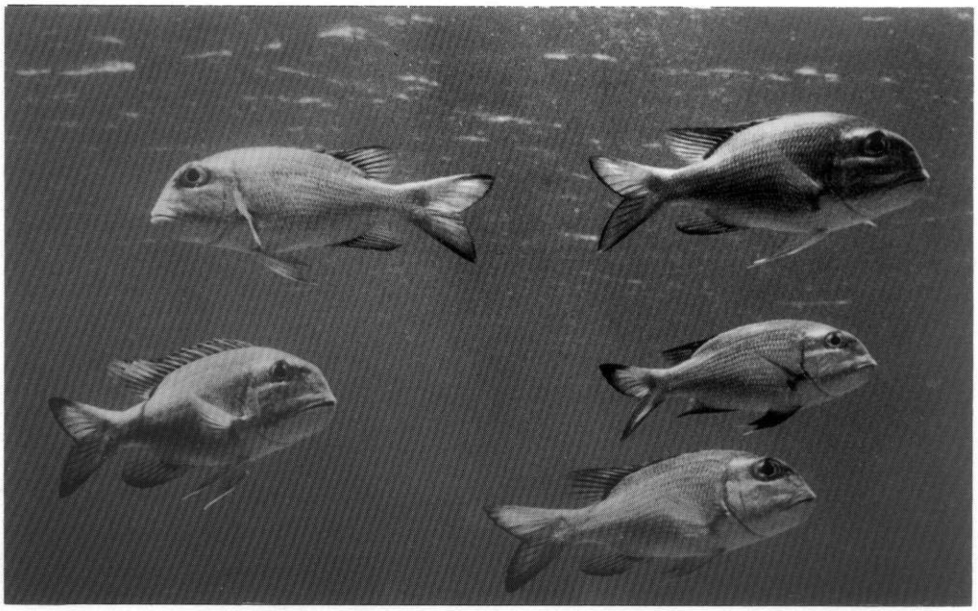

Figure 4 A shoal of big-eye bream photographed with a Nikonos +28mm lens using natural light. Red Sea.

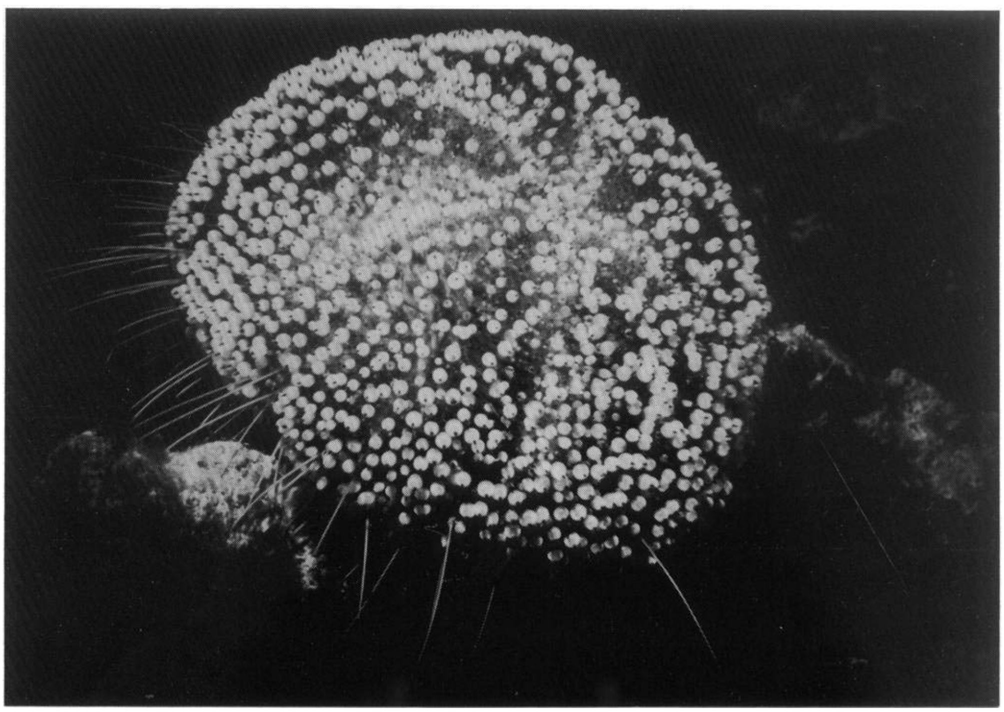

Figure 5 A sea urchin with white poison sacs clearly visible on its spines. Photographed using a Nikonos +28mm lens with push-fit Nikonos close-up lens and distancing bar. The field frame was removed for this picture. Red Sea.

5.3.4 Choice of Underwater Photographic Equipment

There are as many choices of underwater photographic equipment as there are underwater photographers and the only golden rule to be applied is that the photographer ideally uses gear with which he is already thoroughly familiar. It is certainly not an occasion on which he should be trying out equipment that has just appeared on the market. It is clear that the equipment must allow the photographer to tackle the range of tasks expected of him in the field. This will normally mean that the gear must be able to cover the range from extreme close- ups to wide-angle scenic work, regardless of the format used, or whether cameras are housed or amphibious. Certainly 35mm is now the most frequently used format. Within this format land cameras are used quite commonly, either in polycarbonate or metal housings. They do, however, tend to be expensive when compared with amphibious 35 mm cameras, are relatively bulky, and cannot usually cope so easily with extreme close-up work underwater. The most frequently used underwater camera system is that based on the amphibious Nikonos. Because the camera has a long history there is a wide range of accessories available for it, making it extremely versatile despite the fact that it does not have reflex viewing. For those who will be expected to take underwater photographs on an expedition and have not previously had their own underwater system, then the small, robust, reliable Nikonos camera will be the most suitable. The camera has evolved through a number of models, the Nikonos V being the most recent. The later models such as the Nikonos IV and V contain electronic gadgetry, whereas earlier models are completely mechanical. Electronics and seawater are notoriously bad mixers, and a flood in a later model of a Nikonos could mean that the camera is no longer viable. For this reason, many seasoned expedition photographers prefer earlier mechanical models such as the II and III which, although less versatile, can often be got going again after a flood. Second- hand Nikonos 11's and Ill's can still be seen on the market and are well worth considering as the basic expedition cameras.

Those intending to use Nikonos cameras on an expedition will need to acquire two additional items of optical equipment in order that a full range of subjects can be photographed. The first of these is a set of extension tubes and field frames to enable small objects to be photographed (so-called "macro" photography) (Figure 8). The tubes supplied by most manufacturers, when placed behind the lens, will enable the cameraman to photograph objects at a reproduction ratio of 1:2 (or 1:3), at life size, and at twice life size (2:1) depending on the width of the extension tube used. The second necessary item is a close-up outfit consisting of a distancing bar, field frames, and a lens which when placed over the existing camera lens will almost enable the photographer to bridge the gap between the field covered by the largest extension tube and that covered when the standard lens of the camera is focused at its minimum distance (Figure 9).

Addition of a 28 mm lens and either a 20 mm or 15 mm lens to the standard 35 mm lens will provide increased flexibility, the extreme wide-angle lens being required in order to undertake scenic, habitat or diver photography in anything other than crystal clear conditions (Figures 1, 6 and 7). Accessory optical viewfinders will be needed to determine the field of view of these different lenses, since the Nikonos lacks reflex viewing.

Next to a light meter the most important item of non-optical equipment required by the underwater cameraman is an electronic flashgun, for it is necessary to provide additional "daylight" for the film almost immediately the camera passes beneath the water surface due to the fact that water alters the colour balance of daylight, as well as markedly reducing its intensity. It is recommended that the photographer takes two flashguns, one powerful gun which can be used primarily for the scenic, diver and habitat photography, and another less powerful one for illuminating close-up and "macro" subjects. Many of the larger guns are now available with dual power settings, and the photographer may thus feel tempted to take only one (large) gun on an expedition since it can perform both functions. This is a dangerous practice for if something were to go wrong with the gun on the trip, no back up would be available. The possession of a slave sensor in the larger gun is useful since it will ensure that the gun can be fired by the smaller flashgun if a fault should develop in the cable connecting the flashgun to the camera (this is the most likely part of a flashgun to fail - see next section).

Figure 6 A diver taking sediment samples in low visibility conditions. Photographed using a Nikonos +15 lens and fill-in flash to supplement the natural light. West coast of Ireland.

5.3.5 Preparation of Photographic Equipment and Accessories

If equipment has not been used for an appreciable period it is important that ample time is left for preparing and testing the gear before leaving. It is quite surprising how equipment that is apparently clean, corrosion free, well-lubricated and working perfectly well when put away at the end of a diving season, will not be functioning when tried out at the beginning of the next. This statement is particularly applicable to electrical items such as flashguns, where minute quantities of seawater may have tracked along the inside of the electrical cable from the plug, or from the point where the cable enters the main body of the flashgun, and have been slowly corroding the wires away unnoticed within the plastic sheathing.

All gear should be tested, preferably in a saltwater swimming pool (but a domestic bath will do at a pinch) to ensure that there are no leaks and that electrical connections do not fail underwater. If new gear has been acquired, then it should be tested in just as vigorous a way as older items. Exposure tables should be calculated from swimming pool trials for any flashguns that are not familiar items of equipment. A table of basic settings should then be marked on the flashgun in such a way that it can easily be read underwater. I have found that numbers marked on masking tape with Indian ink are particularly durable.

Cameras should be checked to ensure that their shutters synchronise with the flash output from the gun (see Rowlands, 1983, for method of checking). If an electronic flashgun has not been used for some time, then its capacitor will need to be "reformed" or else it will not be capable of producing a full power output.

Figure 7 Diver entering a cave occupied by a shoal of sweepers. Photographed in natural light using a Nikonos + 35mm lens covered by a push-fit 15mm Subawider lens. Red Sea.

Basically this is achieved by leaving the flashgun switched on for a minute or two before discharging it and repeating the process at least half a dozen times, finally ending up by leaving the capacitor charged before the gun is switched off.

Rechargeable NiCd batteries behave in a somewhat similar manner if they have not been used for some time and should be charged and discharged (not fully, or else they may reverse polarity), at least half a dozen times in order to increase their ability to hold charge. If it is intended to use this type of battery in flashguns, then charger units will be needed and it is important to check what voltage supply, if any, will be available at the expedition site. It would be as well for the photographer to ensure that he takes a sufficient number of disposable batteries with him to cope with the situation should the electrical supply be questionable.

Ideally the expedition photographer, no matter what camera system he is using, should have at least one spare camera body and lens, a spare flashgun and a spare light meter. Additionally, the user of a Nikonos system should seriously contemplate taking a second close-up kit and optical viewfinder, since these are items which are most frequently lost during dives.

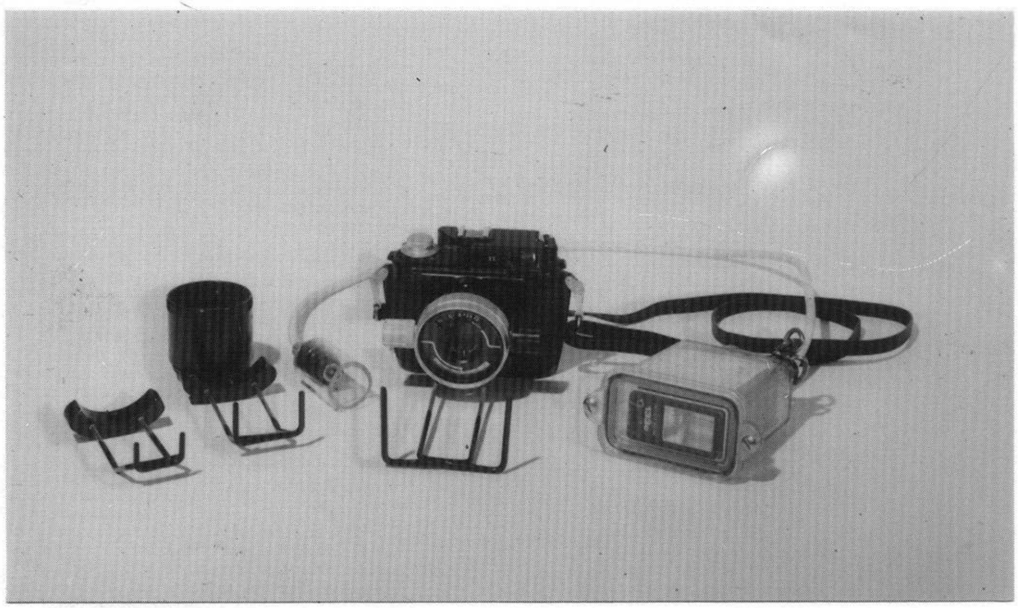

Figure 8 A Nikonos 'macro' system. The camera has an extension tube behind its 35mm lens and is fitted with the appropriate distancing bar/field frame (1:2). Another extension tube and two more field frames (1:1, 2:1) lie on one side and a small housed land flash on the other

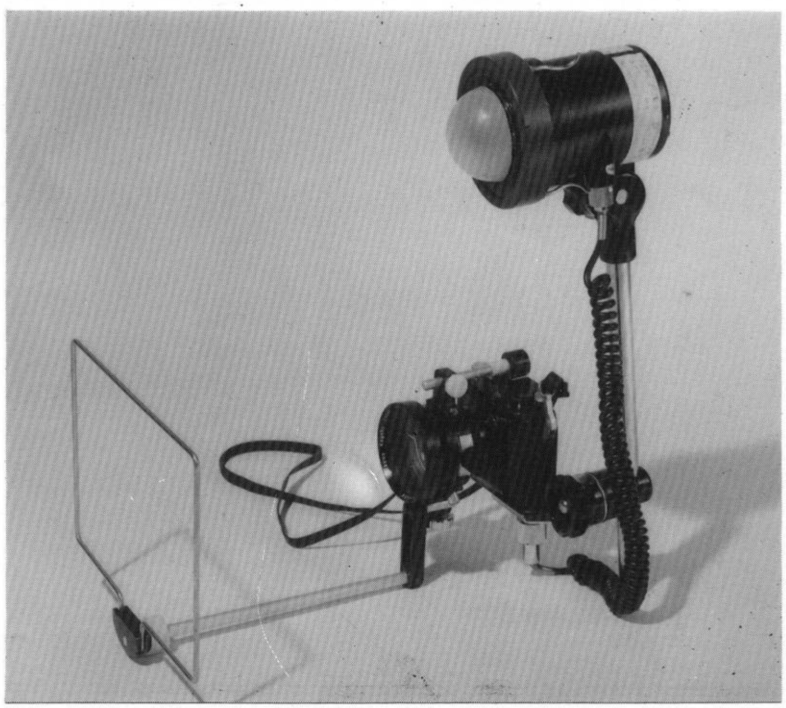

Figure 9 A Nikonos 'close-up' system. A push-fit close-up lens with detachable distancing bar and field frame covers the camera's 28mm lens. A flash gun fitted with a diffuser provides illumination.

Figure 10 A Nikonos II with a 15mm Nikonos lens and a Nikonos optical viewfinder.

Most photographers will find it useful to make a list of essential items. The following is a list of items taken by myself on a 2-week underwater photographic expedition to the Red Sea

Camera bodies: 2 x Nikonos II, 2 x Nikonos III,
2 spare O-ring kits.
Lenses: 2 x 35 mm, 2 x 28 mm, I x IS mm (Nikonos lens),
1 x 15 mm (Subawider).
Filters: I x Magenta, I x Red, (both CC30 strength).
Optical viewfinders: 2x15 mm, 2 x 28/35 mm.
Close up kit: I x Nikonos Kit, I x Ocean Optics Kit.
Extension tubes: I x Oceanics 35 mm set.
Light meters: I x Sekonic Marine L164 + bracket +
2 spare batteries, I x Oceanic OMIOO + bracket.
Flashguns: I x Sunpak Marine 32, 2 x Soltron 133 +
spare coiled lead with fitted plug.
Chargers for NiCd batteries: x 2.
Universal electrical adapters: x 2.
Mallory alkaline AA batteries for Soltrons: 10 x packs of 4.
Narrow-beam spotter torch for night diving + spare bulb.
Rechargeable NiCd torch + charger.
Camera trays + handles and wrist straps: x 2.
Film: 40 x K64, 5 x E64, 5 x EIOO, 4 x E200.
E6 processing kit and collapsible plastic bottles.

Developing tank.
Black cloth changing bag.
Multimeter (to test for wire continuity, shorting
& battery health).
Fine-tip soldering iron and solder.
Wet and dry emery paper.
O-ring grease.
WD 40. Silicon spray.
Adhesives: Superglue, rapid Araldite, Loctite.
Plastic insulating tape.
PTF tape for wrapping around threads.
Jeweller's screwdrivers (normal & Phillips).
Allan keys. Needle-nose pliers.
Small file. Small scissors.
Pointed tweezers.
Fine scalpel with disposable blades.
Toothbrushes for cleaning threads.
Blower brush. Cotton buds.
Small packets of tissues.
Small packets of silica gel.
Pencil eraser for cleaning electrical contacts.
Self-sealing plastic bags for stripped down camera parts.
Box of various screws, connectors etc.
Caribiners.
Fine cord + shoelaces for tying accessories to cameras.
Masking tape.
Self-adhesive labels.
Soft pencils.
Superfine permanent marker pens.
Lightweight foil blanket for protecting cameras from sun.

5.4 EXPEDITION PHASE

5.4.1 Travel to site

Camera equipment must be packed carefully, ensuring that delicate gear is well protected from knocks that it may receive en route to the expedition site. If it is possible, I would recommend that vulnerable equipment is carried as hand baggage on flights overseas. Since my own gear is relatively compact, I endeavour to carry cameras, lenses, flashguns etc, in a large flight bag which will either fit under a seat or in the overhead luggage lockers. In order to save some space, I always carry flashguns with batteries loaded into them. In these circumstances, it is wise to tape over the on/off switch to prevent it being accidentally turned on in transit. It goes without saying that one should avoid having hand baggage weighed at airport check-in desks or else you may well be stuck with a hefty bill for excess baggage! If your camera gear is not sufficiently compact to fit in a flight bag, then a strong well-padded wooden or metal box should be used for carrying gear that must go in an aircraft baggage hold. An insulated polythene carrying container of the type used for keeping drinks cool, is a practical (and cheap) substitute for a designer metal camera case and has the added advantage of being an ideal container in which to keep cameras out of harm's way when travelling around in small boats on site.

Cameras such as the Nikonos are not designed to withstand air pressure changes from the inside and thus, even when carrying cameras in the passenger cabin of an aircraft, it is a wise precaution to remove the rear 0-rings from lenses if they are to be carried attached to cameras. On the whole, I find it more convenient to carry my lenses separated from my cameras and to ensure that the plastic camera body caps are pierced with a small hole to allow for pressure equalisation during the flight.

Most hand-baggage X-ray machines at airports are now considered to be "film- safe" for anything other than ultra-fast films. Nevertheless, it is wise to carry unexposed film separately and to ask that it be inspected by hand rather than allow it to pass through X-ray machines.

Customs officials of some countries are particularly attracted to expensive looking camera gear, particularly if it is brand new, and it is wise to ensure that bills of sale are carried with you on the journey as well as lists of equipment identification numbers.

Inevitably delays occur at airports on long journeys and I have found it very useful to carry camera instruction manuals and books on underwater photographic techniques in my hand baggage, so that they can be perused en route.

5.4.2 On-site activities

On arrival at the site the underwater photographer should set about trying to situate his equipment in an area well away from that in which the mainstream activities of the expedition are taking place. Ideally he should commandeer a table or some other type of hard flat surface solely for camera equipment, with other members of the expedition being left in no doubt that they approach or use this surface at their peril even if it is devoid of cameras at that moment. The area should be as protected as possible from wind, rain and sun. Failing this, the photographer, if lucky enough to have a bed or bunk, can use this as a surface on which to service camera equipment. I have spent many an hour on an expedition kneeling at the side of my bed, not necessarily in prayer, but preparing equipment for the next dive.

Once the cameraman has a designated area in which to work, all the photographic equipment should be unpacked and the cameras, lenses, flashguns, light meters, etc, assembled into systems. I usually have three Nikonos camera systems assembled and ready to go underwater at a moment's notice:

a) "macro" system with extension tubes plus distancing bar and field frame, a 35 mm lens and a small flashgun (Figure 8).
b) a "close-up" system with a 28 mm lens, a supplementary lens attachment, distancing bar and field frame, small flashgun, light meter and optical view finder (Figure 9).
c) a "wide-angle" system with a 15 mm lens, large flashgun, light meter and optical viewfinder.

The close-up system is the most versatile of the three, since the supplementary lens can be easily removed underwater if so desired and the camera used just with its 28 mm lens which will focus from infinity to a minimum distance of 0.6 m.

On none of the systems is the flashgun fixed permanently to the camera, but is easily detachable so that it can be held at any angle relative to the object or scene being photographed. In contrast, it is an advantage to clamp a light meter to a camera as it invariably gets tangled up if left dangling on a lanyard. I also make absolutely certain that accessories such as light meters and viewfinders have safety cords, additional to their normal clamping devices, attaching them to the cameras.

All camera equipment should be prepared before kitting up in diving gear and put to one side in a safe, shaded, position until you are ready to dive. If cameras have to be left in strong sunlight, they should be covered either with a foil sheet or with a light-coloured towel. Alternatively, they can be left in shallow water to acclimate to the water temperature.

If the dive site is to be reached by small boat, then the photographer is well- advised to place the cameras out of harms way in a robust carrying container. Rather than jump into the water carrying cameras, it is as well to ask the boatman to hand them to you once you are in the water or else attach them to a line with a caribiner and lower them gently to a position a few metres below the boat before the dive commences. Once in the water, camera lenses should be checked to ensure that no air bubbles are adhering to the front element.

The techniques for photographing marine life and divers are well documented in texts such as George (1980), and need not be repeated here. If photographs of "divers at work" are needed then the "actors" should be well-briefed before entering the water and a series of easily understood signals worked out. The photographer should continually impress upon divers the importance of not stirring up silt whilst photographs are being taken of them or of nearby marine life. Your assistant-diver, who incidentally will hopefully be carrying your second (or third) camera, should also be well briefed and should keep down- current and to one side of you unless requested otherwise.

At the conclusion of a boat dive, cameras should be handed to the boatman, who should stow them in the carrying container. On reaching the shore, exposed film should be immediately re-wound into the cassettes, the shutter speed dials reset, and the cameras soaked in freshwater for at least 10 minutes before being laid out to dry. On loading a new film, make sure that no water gets inside a camera. Exposed film should be placed in clearly numbered containers and stored in a cool, dry place. Photographic and site details should be carefully logged in a notebook for future reference.

If during the expedition you are unlucky enough to flood a camera, then follow the procedures that are carefully laid down in Rowlands (1983) and you may well be able to save it and even re-use it on the trip. Make sure, however, that the camera is properly serviced immediately on return to the UK..

5.5 POST-EXPEDITION PHASE

Never let exposed film leave your side whilst travelling back to the UK - camera equipment can nearly always be replaced if lost, exposed film cannot! When sending off film to be processed, mark the mailers with the film number next to the return address. This will ensure that you can keep returned film in a time sequence. It is good practice not to throw any slides away, no matter how bad, until you have had an opportunity to study them carefully and hopefully learn from your mistakes.

Slides should be labelled with all relevant details (including the photographer's name) and particularly good ones marked in order that they can be rapidly extracted for slide shows. Ideally slides should be stored in transparent hanging sheets in a filing cabinet. These sheets will enable the photographer to scan slides 20 or 24 at a time when searching for particular subject matter.

Inevitably the photographer will be placed under pressure by other expedition members to supply slides for their lectures. Original slides should only be loaned in exceptional circumstances as they soon become scratched and dirty. It is a good practice to make duplicates of popular slides and ask lecturers to use these rather than the originals.

Prepare slide presentations carefully on a light box, making sure that you run through selected slides in a projector before the lecture. Do not be tempted to show poor images - an audience will always respond more positively to a small number of good slides than to a large number of mediocre ones.

All photographic equipment should be thoroughly inspected, cleaned and lubricated as soon as possible after return to the UK., and any gear in need of attention sent for servicing.

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6 – A more recent chapter on Diving Medicine can be found in the Expedition Advisory Centre publication ***Expedition Medicine*** edited by David Warrell and Sarah Anderson

EXPEDITION DIVING MEDICINE

Peter Glanvill

6.1 INTRODUCTION

This paper examines the most common medical problems on diving expeditions. It assumes the reader is familiar with the basic medical aspects of scuba diving, such as those outlined in the BSAC manual, and that the reader is going to refer to the appropriate reference sources for potential medical problems that might result from the terrestrial environment in which the proposed expedition is taking place (eg. desert, arctic, temperate, mountain, etc.). For an overall view of such environmental problems the reader is referred to the EAC Expedition Medicine manual.

The following text is divided into two main sections. The first deals with the identification of possible problems, and the second deals with their treatment.

6.2 PREPARATION

All members should be fit - not just up to date with their medicals, but fit. They should be as familiarised as reasonably as can be expected with the diving conditions which they will encounter, eg cold water, depth, low visibility diving, etc. A useful adjunct to any expedition leaders file (or the doctor's) is a brief medical history, allergies, blood groups, etc. Do not forget inoculations and dental check ups. Find out what, if any, facilities for recompression are available.

Find out medical arrangements there are in the countries being visited in order that adequate medical insurance can be taken out where it is required.

Long lists of drugs, medical equipment, etc, have been published (for instance the EAC Expedition Medicine Manual). Only take that with which you are familiar and are confident in using. If necessary practice techniques you might have to use, eg, intubation, putting up drips, etc. Although it is not always easy, try and get to know the members of your team before the trip, as personality will affect attitude to illness.

6.3 MEDICAL PROBLEMS

6.3.1 Above Water

This depends on the location of the expedition - if in British or European waters the hazards are not usually great. Further afield, climate and local fauna, flora, parasites, fungi, bacteria and viruses must be thought about. The smaller the organism often the bigger the trouble. Viral gastro-enteritis may sweep through a team and disable it for two or three days. Cold climates introduce the risk of hypothermia after dives, while sunburn and dehydration may be experienced in hot climates. Flora in tropical areas may be poisonous on contact or very thorny, causing cuts which can become infected by parasites (eg, schistosomiasis, giardiasis) in contaminated water. Malaria and other insect vector borne diseases are another hazard with which can expect to come into contact in tropical areas. Fungal infections in tropical climates can cause foot rot, etc. Bacteria cause skin infections and diarrhoeal illnesses (eg, dysentery). Viruses can cause gut infections, hepatitis, colds, and influenzal illness.

6.3.2 Beneath the water

Encounters with marine organisms causing allergic or toxin-based reactions are more likely to cause trouble than attack by larger hostile marine creatures, such as sharks. The threat will vary, depending on location, from weaver fish stings in the UK. to treading on a sting ray in the Caribbean. Awareness of potential threat means it can be avoided.

6.4 DANGEROUS MARINE CREATURES

Can be classified as:

6.4.1 Traumagenic

Sharks, barracudas, moray eels and groupers are all potentially dangerous. Like most animals, they are not likely to cause trouble unless provoked. Provocation may occur in a number of ways from accidental, (eg. putting ones hand in a moray eel's hole), to intentional but misguided, (eg. shark feeding). Injuries are caused by biting and massive destruction of tissue with consequent loss of blood. Trauma may also occur as a result of being bitten by certain annelid worms and by treading or falling on sea urchins or star fish.

6.4.2 Stinging

Marine organisms may deliver injury by injecting toxins into the victim either by bite, (eg. sea snake, blue ringed octopus), or by sting - either by venomous glands (eg. weaver fish, or sting ray), or via nematocysts (eg. sea anemone or jellyfish).

a) *Envenomation by biting* is a problem encountered mainly in tropical waters (eg. by the sea snake).

b) *Envenomation by sting* is a world-wide phenomenon, caused by a variety of fish from the European weaver fish to the stone fish or scorpion fish. Victims may be stung not only by fish, but also by sea urchins or molluscs such as cone shells.

c) *Envenomation by nematocysts*. Nematocysts are the individual microscopic stinging cells of the coelenterates. They consist of a venom filled capsule and a coiled triggered stinging thread. Contact with the victim causes the thread to discharge into the skin. In European waters, jelly fish are the main causes of stings, usually the Lion's Mane *(Cyanea capillata)* in its brown or blue versions, the Portuguese Man o'War, and the Compass Jellyfish *(Chrysaora isosceles)*. Sea anemones can cause skin reactions if an individual is particularly susceptible or if stings are received in vulnerable areas, such as the face, where chronic ulceration may ensue. One British species is the Snakelock anemone *(Anemonia sulcata)*. In tropical waters some jellyfish are extremely venomous such as the sea wasp. In terms of general nuisance value though, corals are probably the most troublesome, coral causes lacerations and these become contaminated by nematocysts and crushed coral. The ensuing wounds become chronically infected. Other corals can cause an intense dermatitis. Some sea urchin spines are coated in venom which may cause injuries which result in miscellaneous toxic reactions.

6.4.3 Poisonous to eat

Unless one is violently conservation minded, at some stage one will have the opportunity to eat some of the local marine life. Even this is not without its dangers. Poisoning can occur in a variety of ways:

a) *Ciquatera fish poisoning.* A large number of reef fishes and some invertebrates which are normally edible can become poisonous under certain circumstances. This is probably related to the ingestion by the fish of toxic marine algae. Causing neurological disturbances, ciquatera poisoning has an estimated fatality rate of around 12% and there are no specific antidotes. It is fairly common in the Indo-Pacific region. Testing the proposed meal on a small animal such as a kitten has been suggested!

Specific fish implicated in ciquatera poisoning include barracuda, sea bass, snapper, moray eels, jacks and surgeon fish.

b) *Tetrodotoxin poisoning.* This follows the ingestion of puffer fish, ocean sunfish or porcupine fish. The poison which is a neurotoxin resides mainly in the gonads, liver and intestine. It was used by the fictional Rosa K-lebb in the lan Fleming novel "From Russia with Love" to disable Bond in the final pages. In Japan specially licensed chefs are allowed to prepare "Fugu" as the fish is known. Eating it sounds like a form of Russian Roulette and there are around 50 gourmet deaths a year from "Fugu" poisoning in Japan.
c) *Scombroid poisoning.* This develops from eating incorrectly prepared mackerel or tuna. An allergic type of reaction is produced as a result of the ingestion of a histamine like substance consequent upon the breakdown of the fish tissues.
d) *Shellfish poisoning.* This may be due to the ingestion of bacteria or viruses and usually is associated with gastrointestinal disturbances. It can also be due to a specific allergy to a shellfish or lastly to dinoflagellate poisoning. Dinoflagellates are planktonic organisms which can sometimes occur in blooms or "red tides" and are then ingested by shellfish. The end result of ingestion is paralysis similar to tetrodotoxin poisoning. It can and has been known to occur in European waters.

6.4.4 Shocking marine animals

Having run the gamut of being stung, impaled on, bitten, scratched or poisoned by marine creatures one ought to finish with electrocution! The electric ray, Torpedo is capable of delivering quite a nasty shock (up to 220 volts if fully charged) and could cause death to a child. More of a risk is that the shocked individual may be rendered temporarily unconscious and drown. One of my patients got a nasty shock last year when a ray he speared whilst snorkelling discharged itself whilst he was hauling it in.

6.5 GENERAL PRINCIPLES OF MANAGEMENT

6.5.1 Trauma

Whatever the cause of trauma whether by shark attack or, as is distressingly common, by mechanical injury from, for example, a boat propeller, the general principles remain the same. Stop bleeding and maintain an airway. Usually blood loss produces the signs of shock (ie. pallor, rapid pulse, rapid respiration and possible loss of consciousness).

6.5.2 Stings

a) *Coelenterates.* These all sting by the same mechanism (ie. discharge from a nematocyst). A victim of stinging by a jellyfish may have after contact, a number of undischarged nematocysts on the skin which should be removed. Firstly remove the jellyfish from the vicinity without touching it - many have very long trailing almost invisible tentacles and even jellyfish washed up on beaches can be capable of stinging, as I have ascertained for myself! Following this, the remaining undischarged nematocysts must be immobilised. I think the approach to dealing with the highly venomous sea wasp sting gives the general idea. The sea wasp is a fairly small jellyfish which causes most fatalities off the North Australian coast. Its toxicity varies with its size. Being small and almost invisible it poses a considerable danger to swimmers. Victims of sea wasp stings have been know to die within minutes, although as with nearly all cases of poisoning the morbidity depends on the age and physical health of the victim.

Firstly get the victim out of the water, then immobilise him - sea wasp stings in particular are said to be excruciatingly painful. Next, if a limb is stung, apply a pressure bandage remembering that it will need loosening at some stage to permit circulation. Then neutralise any remaining nematocysts with alcohol vinegar or any drying agent to hand. Watch out for stings when removing tentacles. Lastly get the patient to a hospital or doctor where antitoxin may be available. These principles apply to a greater or lesser degree to most jellyfish or anemone stings.

b) *Coral cuts.* Finally I shall deal with a common cause of trouble here namely coral cuts or abrasions. Coral is troublesome because of its abundance in tropical waters and the dual nature of the trauma it produces. Firstly there is the purely mechanical effect of a laceration from the coral's sharp edges. Secondly, there is wound contamination from the organism itself and from bacteria covering the slimy outer coat of the coral. The initial wound may look quite small and clean but will smart after a few hours with the development of inflammation around the wound. Over the period of a few days, the inflammation may spread to the extent of abscess formation and systemic symptoms such as fever and enlarged regional lymph glands. A similar syndrome can be seen from cuts sustained in temperate waters. I personally developed a number of small abscesses on both hands after a 2 hour long immersion off the Cornish coast a kilometre from a sewage outfall. Immersion causes softening of the skin and encourages the entry of infective organisms.

   Treatment of coral cuts involves taking the original injury seriously cleaning the wound well and following this with the application of an antiseptic or antibiotic preparation, (eg. Betadine paint or Flammazine).

c) *Sea Urchins*. Even if the sea urchin is not venomous wounds caused by the spines of most species can be most unpleasant. The spines are difficult to remove, tending to break off in the wound because of their brittle nature. Some of the venomous species can cause systemic illness as well. The first principle is to remove any spines if possible. This may require their being dug out rather than removed by splinter forceps. I can vouch for the fact that this is painful, having had a number removed from my hands and feet after a fall in the Mediterranean some years ago. Even the sea urchins in British waters can inflict damage, one species being exceptionally common in the intertidal zone on the Irish coast. Breaking up the spines in the tissues by increased trauma seems to help in some cases, although victims may not appreciate the affected limb being vigorously pummelled! If the spines are left alone, they provide a route for infection although if asymptomatic, they will eventually be absorbed by the body.

d) *Stings from venomous fish*. For some reason, the toxins injected by fish are similar, although vary in their potency. The methods used to treat the sting of a weaver fish and those used for the sting of the far more exotic tropical stone fish are essentially the same.

Firstly remove the victim from the water, lie him or her down, and elevate the affected limb. Remove any venom or spines then immerse the area stung in hot water (up to 50°C). The rationale for this is that the toxins involved are heat labile (ie. they are altered by heat). Heating will relieve pain. Injection of local anaesthetic at the site of injury will also help. If the sting is severe, seek medical help.

e) *Fish poisoning.* Little needs to be said on this subject because avoidance is self evident. No stale fish, no puffer fish, no shellfish from contaminated waters and awareness of ciquatera poisoning if eating reef fish. Ciquatera poisoning initially causes muscle cramps, followed by weakness and numbness around the mouth, nausea, vomiting and diarrhoea. Severe cases develop rashes and all sorts of nervous system signs. Apart from simple first aid, treatment is symptomatic. Get the patient to hospital as fast as possible.

6.6 CARE OF THE EARS

Many divers' hopes of a good dive founder because of ear problems. While some problems are hard to avoid, (for instance the common cold), the following techniques may help to avoid trouble in other areas. All expedition divers should know how to clear their ears properly and regularly. Some people frequently have problems with just one of their ears and in recent years this has been found to be associated with a congenital abnormality of one of the bones at the back of the noes which causes abnormalities in air flow. This finding is relevant because it can be corrected by surgery which involves only a few days stay in hospital. The bad news is that there are few surgeons doing this operation and it is only available privately as far as I know.

Having managed to clear his ears, the diver then has the problem of inflammation and infection in the external ear canal - otitis externa. Divers in tropical waters and those in the humid conditions encountered in saturation diving chambers tend towards this condition. In saturation divers, the condition known as "pye" after the name of the infecting organism Pseudomonas pyocyanea. Although potentially troublesome this organism if of great economic importance in some countries.

Generally speaking the advice for ear-care seems to be as follows. Firstly do not try and clean the ears yourself - put in nothing larger than your elbow. Secondly unless the ear is blocked with wax to the point of deafness, do not have it removed. It has a protective function both by maintaining a low pH and by rendering the sensitive ear lining waterproof. Removing wax removes a protection against infection. Thirdly, ear drops after a dive may be helpful but what sort is a matter for discussion. Alcohol drops have a drying effect but also dissolve wax so may not be as beneficial as all that. One author suggests acetic acid drops which raise the pH have a drying effect and do not dissolve wax. If infection does occur it should be treated promptly with antibiotic drops (eg. Otosporin) and the possibility of fungal infection borne in mind.

6.7 DECOMPRESSION SICKNESS

Obviously on some expeditions, deep diving (over 30 metres) will be undertaken. Even with very efficient planning , decompression sickness may affect a diver. Awareness of its many manifestations is important, as are contingency plans to deal with such an eventuality. In a remote location it may not always be feasible to do everything by the book. Recompression facilities may be miles distant and several hours travel away from the site of the incident. The use of one man recompression chambers would only be of use as a very temporary stopgap - they do not allow the observation or treatment of a sick diver by an attendant. A pragmatic approach may be required in acute cases, namely the use of re-entry recompression. The author knows of divers in this country who have done this in cases of extreme exposure rather than decompression sickness.. Where the option may be a wait of an hour or more during which severe symptoms will definitely develop and be possibly less amenable to treatment, there is something to be said for it. However it should be regarded as an extreme last resort and the relevant USN air compression tables for such an event should be available and strictly adhered to. The best policy when faced with a decompression or other pressure- related event (Barotrauma) is to give the patient part-oxygen breathing gases, place the victim on a saline drip and transport them as quickly as possible by the most expedient means (eg. by coastguard or military helicopter) to a recompression facility which is adequately qualified and rated to deal with the incident involved. Note: not all recompression chambers can deal with very deep- related incidents. Non- recompression treatment of decompression sickness (ie. treatment by drug)s is largely ineffectual and the literature is full of inconclusive trials.

6.8 SEA SICKNESS

Many expeditions are now boat based and sea sickness is therefore quite a hazard. Sea sickness is acutely disabling and even after its passage may leave the victim feeling drained. In the author's experience it is a common research reason for dives to be aborted. Some divers, whilst feeling violently sea sick on the surface, miraculously improve once in the water. However, this is not always the case and sea sickness underwater is well recognised. Vomiting underwater is not very nice, and unless the diver co-ordinates it correctly, he or she will drown. Preparations to control sea sickness tend to be sedative in their action and must be regarded with caution by the diver. Modern preparations include cinnarizine which is said to be less sedating and is now probably the most popular anti- motion sickness preparation amongst those in the know, skin patches which deliver slow release hyoscine, and powdered ginger. I have no direct experience of any but the first, which I found to be very sedating although others speak very highly of it.

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7

HIGH ALTITUDE DIVING

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7.1 INTRODUCTION

It is only in recent years that diving at high altitudes has become an aim and a specialty in its own right. Previously, interest in diving and altitude effects has been almost exclusively concerned with the problems of flying and mountain travel immediately after diving and the prevention of decompression sickness. Now we find diving taking place in mountains at around 6,000 metres.

High altitude diving has not been extensively studied and there are risks in such ventures - both physiological and environmental. High altitude diving expeditions should not be undertaken lightly. Among the factors which need to be considered are:

7.2 AREA

Generally, the higher one climbs the more remote the area one is travelling in. This fact alone can provide problems with logistics, communications and medical support. The chances are that recompression facilities will not be available and few indeed are the expeditions which can call on helicopter support. So what is the procedure in the event of a bend or embolism? As well as diving abilities the team will also need the skills to cope with high altitude areas. They must be competent in mountaineering, outdoorsmanship, first aid, hill walking and, almost always, have the ability to carry heavy loads over long distances and difficult terrain.

7.3 LOGISTICS

Men, equipment and rations have to be moved to and from the diving site. Depending on the remoteness of the site and the type of ground, movement can be completed in a few hours by vehicle or in days, and sometimes possibly weeks, on foot. Diving cylinders, lead weights and other bulky and heavy equipment will often have to be manhandled over substantial distances and across awkward obstacles. Ordinary backpacks are not always best suited to carrying diving equipment, as they have difficulty coping comfortably with the shape and bulkiness of some items, and they tend to retain most of the moisture if the kit has not been fully dried - not always possible in the hills.

As well as diving equipment an expedition will be expected to take along other kit such as personal items (e.g. sleeping bags, spare clothing, mess tins, etc.), team equipment (e.g. tents, stoves, ropes, etc.), scientific and medical equipment and, of course, rations. It is often worth considering the use of non-divers on an expedition to help carry equipment, lead climbs and supply other specialist skills.

7.4 DECOMPRESSION

For practical purposes altitude diving can be divided into two sections: low altitude (100 m - 3000 m) and high altitude (3000 m and above). No alterations need to be made to the decompression tables if diving is less than 100 m. Also standard decompression tables are designed for seawater, no conversions should be made to freshwater as this will decrease any safety margin.

LOW ALTITUDE: Depth adjustments to decompression tables for diving at low altitude:

Under 100m No adjustment.
100-300m Add 1/4 actual depth to obtain table depth.
300-2,000m Add 1/3 actual depth to obtain table depth.
2,000m-3,000m Add 1/2 actual depth to obtain table depth.

HIGH ALTITUDE. NO tables seem to exist for diving above 3,000m. Dr Tom Hennessey (1977), however, recommends the following conversion formula:

DEPTH (Tables) » 2 x DEPTH (actual)
(Barometric pressure +1)

(Barometric pressure must be in bars)

It is recommended that, whenever possible, no-stop dives should be undertaken. If planning to dive above 3,000 m for the first time then specialist advice should be sought (e.g. Diver Performance Research Unit, University of Lancaster; Admiralty Marine Technology Establishment (Physiological Laboratories), Alverstoke; Admiralty Experimental Diving Unit, H.M.S. Vernon.

7.5 ACCLIMATIZATION

Whenever possible, acclimatisation should be carried out for low altitude dives. For dives at high altitudes acclimatisation must always be undertaken. A very sensible approach is a gradual rate of ascent with sufficient rest periods at intermediate altitudes. Apart from any acclimatisation necessary for climbing above 3,000m, 24 hours should be spent at the dive site before undertaking any diving, to decompress to ambient local pressure before diving.

7.5.1 Altitude sickness

This is a real problem above 3,500 metres, although it has been known to occur at lower levels. Altitude sickness can be prevented to a large extent by proper acclimatisation (see above). All divers on high altitude dives (that is above 3,000m) should be familiar with the symptoms and treatment of altitude sickness. The principal symptoms are headaches, weakness lethargy, sleeplessness, swelling (oedema), nausea, loss of appetite and often irregular breathing. Altitude sickness has killed and still does. The UIAA Mountain Medicine Data Centre, Department of Neurological Sciences, St Bartholomew's Hospital, 38 Little Britain, London EC I A 7BE has a number of leaflets on this subject including Acclimatisation, Acute Mountain Sickness and Travel to High Altitudes.

7.5,2 Breathing gases

Expert guidance should be sought on the use of compressed air or other gases at extreme altitude. Dives using pure oxygen have been made at altitudes around 6,000m, however, very little is known about this topic. Whichever gas is used, do not fully charge the diving cylinders at sea-level as allowances must be made for gas expansion with decreasing atmospheric pressure.

7.5.3 Ice

Be prepared for ice diving. Preparation means both taking the equipment for cutting through the ice (from hammers to augers and even chain saws) and, more importantly, prior training in the techniques of under-ice diving.

7.6 GENERAL POINTS

These are just a few points which may come in useful:

NEOPRENE contains bubbles which will expand at altitude and can make a diving suit unwieldy. Rubber dry-suits, if worn with insulating thermal undersuits, are much more suitable.

MEDICAL KITS should include insect repellent, aspirin (or similar), lip salve and sunscreen. Use a good sun lotion and keep the back of the neck covered; a sunburnt neck does not go well with a rubber neck seal.

TENTS come in various shapes, sizes and weights. Whichever type is taken as a personal tent it is also worth thinking about taking along a single large tent which can act as a changing room, office and equipment store room.

WATCHES can go awry at altitude and it is often a good idea to take along a few spare cheap digital watches in reserve. Watches are an essential tool in diving.

REPAIR KITS, sewing kits, suit mending kits, etc are essential. Unfortunately they also tend to be slightly weighty. Give them careful thought.

ROPE AND CORD are excellent items, not only for hill walking and repair jobs, but also for diving tasks, jackstays, shot-lines, survey lines, etc. Rope will depend on the type of expedition being undertaken, but 15-20 m of cord will cover most functions.

THERMOS FLASKS are very useful items. A hot brew following a dive in an icy lake is always welcome. At high altitudes, however, it can take a long time to make a brew and hence the use of thermos flasks.

CAMERAS AND HOUSINGS for underwater use are designed to resist external, not internal pressure. Ensure that ambient pressure can be maintained within the camera body during ascent, eg. remove the lens from the Nikonos before ascending, or remove pressure "0" rings. The same goes for depth gauge and torches.

SACRED SITES. In a number of remote areas mountain lakes are considered to be holy shrines and diving or even swimming in them is taboo. Do not break these taboos.

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8

BIOLOGY AND CONSERVATION ON DIVING EXPEDITIONS

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8.1 INTRODUCTION

The study by diving expeditions of marine or freshwater life is appealing since life in some form or another can be expected to exist at a very wide range of potential sites. With many aquatic areas of the world being threatened by man's activities, and some of the larger species on the verge of extinction, diving expeditions can provide extremely useful information on these subjects. The aim of this paper is to provide guidelines to key decision areas involved with biological expedition diving based on a realistic assessment of what is possible on such expeditions.

8.2 EXPERIENCE AND COMMITMENT

Many groups write for ideas for expeditions involving marine biology and these divide roughly into two groups.

a) The largest proportion are those with comparatively little background of expeditions or biological projects.
b) The second category involves experienced divers often with quite specific aims.

8.2.1 Inexperienced groups

The requirements of such groups are considered here, because if motives are recognised honestly from the outset, such expeditions can achieve a great deal in relation to developing the experience of the personnel (section 4) and ultimately the collection of useful biological information. Enquiries from such groups form a large proportion of those received so it is very important to provide advice which is both realistic, and which gives positive encouragement to people beginning to develop their expertise.

Sections 3 and 4 below are aimed mainly at such groups, but should also be considered in detail by more experienced groups.

8.2.2 Experienced groups

Marine biological diving expeditions are no longer novel, and for experienced expedition groups there are not only a wealth of potential projects, but also a wide range of expertise to draw upon. Experienced expedition groups would probably commit at least 80-90% of their energies on completing strictly defined expedition objectives. Such objectives might involve very intensive study at just one site, or completing dives at what are aesthetically very unappealing sites.

8.3 THE INITIAL ENQUIRIES AND PREPARATIONS - WHAT YOU SHOULD ASK YOURSELVES AND OTHERS?

A typical enquiry might be:

"Can you give us any ideas for an expedition/project . . ?"

Before any ideas can be provided it is essential to know several things:

8.3.1 What are you or your group interested in, exploring lots of sites, looking at wrecks, deep diving, studying sponges, fish, urchins, lagoons, coral reefs, etc? It is surprising just how often people do not give any interest whatsoever. For any leader to motivate a group of expeditioners it is very important to have an interesting series of goals to pursue.

One key way to decide on objectives is to see if any members have specific interests or expertise. Underwater photography for example, can play a valuable role in survey work and this side of your skills might be developed.

8.3.2 Which geographic area? So many biological questions are site specific and it is essential to know where the expeditioners want to go. A very important consideration is that a variety of site options are available depending on particular weather conditions in the region which is being visited; this is quite essential for those groups just starting out on their expedition experiences. In this regard the West coast of Scotland provides ideal conditions.

8.3.3 What time of year? Many large species show seasonal migration patterns, and so if you are planning a winter expedition you would have to take this into account.

8.3.4 Enquiry points should be as specific as possible. That way you will get better answers to your enquiry. For example: "give me your contacts in Skye?", will get a better response than, "what contacts do your have in Scotland?"

8.3.5 How long do you want to spend undertaking the project? What proportion of time do you want to spend doing dives to complete the project aims? This will determine the whole emphasis of the expedition.

8.4 EXPEDITION RELATED ACTIVITIES

It is very important to establish the level of motivation and experience of any group and then develop realistic and achievable goals. The expedition-related activities outlined below are an extremely valuable pre-requisite to completing what one might term more advanced expedition objectives.

8.4.1 Dive training

Many groups have a limited range of diving experience (ie, less than 50 dives per member): for example one team of 12 divers I had the misfortune to lead once only had 22 hours of aqualung training IN TOTAL. Similarly if you are asking someone to lay a line underwater it is no time to discover that this is his first sea dive!

A carefully planned expedition can, however, give inexperienced divers an extremely valuable and intensive lead into different types of diving (eg, drift dives, deep dives, night dives) and this, as a primary objective, should never be discounted lightly.

8.4.2 Working underwater

Any biological objective has to assume a certain level of diving competence in order that the additional requirements of the particular expedition can be completed effectively. It is important to do both dry runs and pool/sea training if equipment is being used for the first time, eg, writing boards, laying lines etc. The KIS principle should always be kept firmly in mind - Keep It Simple. It is far more effective and safer to get one job completed effectively, than to attempt two or three jobs and bodge them.

8.4.3 Knowing where you are going

A familiarity with the particular underwater environment can prove invaluable when moving on to consider working underwater and the choice of a project question. Projects which enable a wide variety of sites to be visited are very valuable or even essential with preliminary expeditions. Exploratory diving "to see what is there" is entirely justifiable and can prove extremely valuable if careful dive logs are kept. The Marine Conservation Society has just produced an expedition dive log which aims to collect biological information.

8.4.4 Learning about marine life and underwater habitats

Many divers have never had any experience of identifying marine life at all. In such circumstances it is better to assume no prior knowledge at all and take steps from that basis. Expeditions which are designed with the objective of teaching the participants about the marine life of the area or how one might describe the underwater environment are entirely justifiable ways of developing the skills that people will need to achieve more advanced objectives. Group debriefing, with the use of collected specimens, slides and the identification books are excellent ways of teaching recognition skills whilst on the expedition.

The basis of Marine Conservation Society (MCS) projects is to enable divers to learn about the marine life they see whilst diving, and not just act as "samplers/collectors* for scientists. This leads on to many avenues of interest which divers can then follow under their own motivation.

8.5 THE QUESTIONS TO BE ASKED

With any scientific endeavour the question one is asking is critical to the design and strategy one adopts to obtain the answer. The questions will usually have to be posed by a trained biologist.

A simple flow chart is useful (Fig 1. from Earll, 1976)
Question ----——---——-------> Answer

Logistics

The bigger the question the greater logistical support needs to be. Ideally the logistics and organisation should be geared up primarily to answer the questions being asked and not the other way round, as often seems to be the case. Earll (1976) describes a detailed version of this flow chart which might be considered for survey work (Fig 1).

The project ideas and original questions, such as; what is found there? How many? How deep? Why? What behaviour? What size? What time of day? Is it affected by man? etc., will arise in a variety of ways. Work in marine parks or nature reserves, matching "ground truth" to satellite images provide exciting possibilities. There is no substitute for wide reading (eg. Progress in Underwater Science) and discussion of ideas with people who have a wide range of interests, at the "question generating phase".

Local scientists should also be contacted for help and advice, since they may be able to suggest sites or questions.

8.6 METHODS

The techniques for working underwater have been detailed by many authors, eg, Earll (1976), Gamble (1984). It is crucial that expedition personnel are familiar with the equipment and methods. If they are not, training should be undertaken before the expedition starts. The more complex the equipment, the greater the need for trial and training. This saves time on site and also stops uncertainties developing in relation to the performance of equipment. The MCS Equipment and Methods notes describe equipment in such a way as to help with its construction.

8.6.1 Identification of plants and animals

Biological work, of necessity, will usually require expedition members to recognise animals and plants underwater. If good guides are available it is surprising how quickly recognition skills can be acquired. Again a methodical approach to species recognition before the event and then dedicated training sessions at the beginning of the expedition can develop good skill levels. A good example of this was one group who did an assessment of the large fish seen at a wide range of diving sites around Cyprus, having done some initial training. This type of study might be conducted in relation to the effects of various types of fishing, including spearfishing at a site.

8.6.2 Single species studies

With an inexperienced team, projects involving single species are an obvious choice. Studies on sea urchins, kelp, the crown of thorns starfish, or a particular threatened species are typical examples. It is important to know that your chosen species does occur in the area you select for the expedition! One expedition to study the Crown of Thorns starfish in the Red Sea only found 6 in 10 weeks; each starfish "cost" £500!

Searches for particular species, studies of their distribution, and abundance in certain habitats can be carried out effectively by large teams. A variety of mapping and transect studies are often the appropriate technique for this type of project. Studies on endangered large vertebrates, seals, whales, turtles, etc, will require particular expertise. Someone will always know more about the animal and population in question than you do at the outset. Often specific international programmes will have already been completed or be underway; sometimes conservation measures might actually prohibit you from studying the population in question.

8.6.3 Survey - studying what's there

Recording where animals and plants are found in relation to a variety of environmental factors, eg, light-depth, or water movement is a common expedition objective. Many MCS expeditions have studied the fauna and flora of parts of the UK. coastline. Such surveys whether "amateur", "professional", or mixed will always depend upon the underwater recording skills and experience of the personnel. Many so called amateurs could be counted upon to provide a far higher standard of recording skill than say a biology graduate. Experience, perception and recording skills are important for survey participants given the wide range of species and habitats one might find underwater.

In practice, comparability between dive pairs is virtually impossible to achieve with underwater recording because of the wide disparity of recording skills. Either the information of the weakest teams must be discarded or their data be accepted as the lowest common denominator. This problem can be overcome on land, or if results from different pairs are pooled for dives at the same site (Earll, 1982).

Checklists (see below) for use both above and below water also helps in standardising results, as can pairing experienced and inexperienced team members.

The decision about whether "reconnaissance" diving over a wide area or more intensive collections at fewer sites is desirable must depend upon the survey objectives. In clear waters a good deal can be accomplished by snorkel surveys of diving sites where intensive study might later take place. Site selection and the strategy for position sampling stations is detailed in Earll (1976).

8.6.4 Checklists

a) *Species*. Species information is difficult to collect systematically, because individuals ability to see, recognise, or identify life varies considerably. On MCS surveys, divers have been asked to record all the species they positively recognise with notes on depth, habitat and abundance. They are also encouraged to collect small pieces of species they do not recognise for identification on the surface. Once on the surface, the information is transferred to a standard checklist of species which orders the records (usually by phyla) making report writing easier. It also acts as a memory jog for species seen on the dive. A variety of species checklists are available for particular regions of the UK. or projects, eg, SEAWATCH, on coral reefs REEFWATCH. Key species or habitat features can be marked on the underwater recording board to act as memory jog underwater. Another device for increasing peoples identification skills on expeditions is to give particular members of the expedition the responsibility for collating all the records of one particular phyla - like the molluscs or starfish. This has also proved to be a useful way of improving identification skills.

b) *Habitats*. The use of a structured habitat recording sheet which is completed after the dive makes the analysis and reporting of results much easier. A variety of habitat sheets are now available for UK waters and coral reefs (eg, REEFWATCH). Care should be taken to ensure that such sheets are "completed" systematically so that comparisons between sites can be undertaken. It has also been found that the subjective description by the diver is of great value, as are sketches of the seabed topography. Many divers can undertake habitat recording tasks without the requirement of biological identification skills (Dipper, 1981).

8.6.5 Monitoring

Monitoring studies are those which require the completion of a clearly defined scientific procedure over a period of time at the same site. In general, such studies are seldom undertaken by expeditions. However, in the long term (> 10 years) profound changes in populations and communities can occur for a variety of reasons. Since we know comparatively little of the reasons for such changes, repeated visits to a particular site may well be justified, as long as sites are documented in detail (much more detail than usual on surveys), so that sites can be revisited and changes measured. Documenting how to relocate the site, with the use of detailed maps and photographs is essential.

8.6.6 Experimentation and technical measurements

Studies of physiological processes, the physical structures of the water column, especially at remote sites requires very considerable levels of logistical support. British scientists in particular seem to have been adept at such studies, eg, the Chagos expedition. High levels of co-operation, and long lead in times and planning are essential for such projects. The calibre of the participants also has to be very high.

With more sophisticated equipment or methods, training and expertise is essential, as is some knowledge of the species/communities which are going to be encountered. The number of people involved with such experimentation is often rather small.

8.6.7 Specimens

Whether within the United Kingdom or abroad, collection of specimens, by individuals or large expedition groups, are often a key element of the results collected by expeditions. Expert advice should be sought in relation to how best to collect and preserve the group/s of species likely to be taken. Collections from particular sites, especially rocky nearshore habitats have seldom been made and museums or group specialists are often very interested in expedition collections. Collections can frequently be made quite justifiably because of the absence of any information on a site. It is essential that such specimens should be accompanied by detailed notes on depth, date, habitat and name of recorder. Good underwater photographs are also very useful since many species change their form and colour completely once preserved. MCS experts can help to provide information about particular groups. If specimens are to be collected for experts, detailed instructions on preservation techniques and the quantities of specimens needed should be obtained.

8.6.8 Photography

Many of the plants and animals found underwater, especially in the more remote parts of the world will have never been photographed alive before. Photographs of the species in their natural state, or of groups of species (communities) and wider panoramic photographs which give an impression of the underwater habitat, have all proved extremely useful in the past. Photographs in the latter two categories can be analysed after the survey for detailed information about cover of the habitat by particular species, etc. However, the time taken to analyse such photographs in relation to the detail they can provide, should not be underestimated. Developing photographs on site using Ektachrome film can be extremely valuable, especially where the photographs are going to play an important part in the final results, such as in monitoring studies.

Photographs of the methods and equipment employed underwater should be given a high priority since these can be invaluable in communicating your results to others (George et al, 1985).

8.6.9 Report writing

Clearly it is important to produce reports on expeditions to satisfy a whole range of requirements, both popular and scientific, if the scientific methodology is sufficiently well organised - simple reports - without undue embellishment can be completed with reference to species and habitat checklists, or measurement forms relatively quickly. It is extremely valuable to ensure that raw data, completed information sheets in particular, are kept in good order. A report's main function will be to explain the raw data, and to ensure that third parties have copies for security in the long term. Often the study sites which will not be visited again, or not for many years, and so it is important that results are communicated and secured. Museums in particular can fulfill this latter role, but often there will be particularly appropriate institutes or organisations.

8.6.10 Accuracy of the results

If the results of such work are to be used for scientific publications, the skill of the least able team member is the lowest common denominator, and so efforts must be made to make adjustments for weak links. This problem can be overcome by asking pairs of divers to complete exactly the same task at the same site so that results can be pooled and between pairs, variation assessed. (Earll, 1982).

8.7 OTHER ASPECTS

8.7.1 Acquiring a marine biologist

Teams who obviously lack any biological expertise will often try and acquire the services of trained biologists. Selection of the biologist should be based upon the biologist having some previous knowledge of the area to be visited and the problems likely to be encountered. If you put a marine biologist on a coral reef for the first time, he will be just as perplexed as the rest of you! The motives and objectives of the group will have to be explored realistically if the expedition is to be productive. Seeking the advice or direct supervision by scientists in the country one is visiting is an under-used avenue which can be particularly productive, and should increasingly become an essential part of expedition planning.

8.7.2 Team size and composition.

This should be considered carefully in relation to questions, objectives, logistics. Problems can arise where an excess of expeditioners leads to the formation separate sub-groups. This usually arises from a mismatch between the objectives and the logistics. The problem can be heightened if one group are the scientists and the others the "helpers". This can be a serious problem and should be taken into account at the planning phase. Tasks, such as searching, often require large numbers of people underwater and should be adopted if large teams have to be accommodated. Often in relatively unskilled groups, particular individuals may have useful skills or interests, for instance photography. If this is the case, it is well worth concentrating particular objectives around these people.

8.7.3 Boredom

Initially divers will, for a period, be quite happy to undertake routine procedures without necessarily understanding why they are doing the task in hand. However, boredom soon sets in, if tasks are left unchanged for too long a period. This problem can be overcome if the group members are actively encouraged to develop their own skills during the period of the expedition.

8.7.4 Finances

Often groups will try and run expeditions to acquire grant aid, sponsorship, etc. Whether to go for this approach or not is a very critical decision. In my experience it is often far more effective to cost the expedition as if team members were covering all the costs from the outset. That saves a lot of wasted effort with letter writing to potential sponsors. Recently a number of diving expeditions to far flung corners of the world have come back with members owing large repayments to the bank. One wonders whether this would have been necessary if the team members had a rather more realistic approach to what they were seeking to achieve. For example, first hand experience of coral reefs can be simply gained by going on cheap group package holidays to the areas in question!

MCS since 1977 has been organising between 4-6 week-long expeditions each year to various remote diving sites around the British Isles. Whilst various sums of financial support have been obtained from time to time for specific expeditions, the maintenance of such a programme has relied mainly on realistic costing and the direct contributions of team members. A large programme of expeditions cannot be dependent upon the vagaries of acquiring sponsorship to determine whether expeditions will or will not take place. If participants are taking their holidays to attend the expedition and paying the themselves, then this has to be taken into account when objectives are set.

Often the logistical support of the services, or of government/conservation agencies can be drawn upon to provide some of the more expensive pieces of equipment.

8.8 CONCLUSIONS

Expedition organisers must, at the outset, be honest with themselves and with those people from whom they are seeking advice and assistance. The definition of a realistic set of objectives whether these be "expedition related" or "advanced", is the key to the decision making process. If your expedition clearly falls into the "expedition related" category, this should be recognised and steps taken accordingly.

For experienced expedition groups the definition of the questions to be answered is the critical decision from which all else flows. There is now sufficient expertise available to be able to effectively carry out biological research in the shallow seas of the entire world, but appropriate expertise must be sought and acted upon.

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UNDERWATER ASSOCIATION publications: Their journal Progress in Underwater Science detail many underwater studies, methods and techniques - details can be obtained from: Erika Charlier, Portway House, Stratford-sub-Castle, Salisbury, Wiltshire, SPI 3LD.

UNDERWATER ASSOCIATION'S Code of practice for scientific diving also outlines procedures for working in novel, potentially different and dangerous underwater environments.

9

BIOLOGY AND CONSERVATION PROJECTS: A PRACTICAL APPROACH

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9.1 INTRODUCTION

There are many opportunities for carrying out marine biological work on expeditions, but there are also limitations. The paper by Earll introduces some of the possibilities, while stressing the need for comprehensive planning at all levels, and the application of the usual ground rules concerning dive training and procedure. He also emphasises the importance of having a knowledge of what is likely to be found in the area to be visited, and of being able to recognise and work with the species and habitats in question.

This paper looks in detail at the types of project that can be undertaken and at the equipment and personnel required in order for them to be a success. The comments are directed especially towards overseas expeditions, although they apply equally well to those proposed for the British Isles. An attempt is made to provide practical advice on devising projects, together with sources of information which are needed in putting together the work programme. Particular attention is drawn to conservation-orientated projects. As well as being useful, expeditions with a conservation-bias probably have a better chance of attracting financial and other support than those that are "pure" biology.

9.2 THE PRELIMINARY IDEAS

It is essential that a close match is made between the desired project and the expertise required and available. Most projects can be attempted at a variety of levels, from simple to more detailed and complex. Much depends on the interests of tackling particular problems, as well as the logistical side (i.e. the equipment, time, and number of people available). There is a general tendency to be over-ambitious with regard to the work that can be achieved both underwater, and subsequently, during the preparation of the expedition report. It is crucial that at least one person is committed to planning and developing the project work well in advance of the expedition. Aims and methods have to be carefully and critically considered, and discussions held with expedition members and knowledgeable contacts so that foreseeable problems can be acted upon well before the expedition leaves.

9.3 RESEARCHING THE PROJECT

Some ideas of projects, and what they involve, are given at the end of this paper. Once the basic decision has been taken as to location, and at least a broad idea for the project has been decided, the next step is to develop the plan in detail and establish the broad aims. It is essential to collect together as much background information, and make as many contacts as possible. Initial ideas may have to be adapted in the light of new information, and it is often best not to have too rigid an approach in the early phases. There are two main sources from which information can be gleaned, and various people who may be willing to help and advise.

9.3.1 Publications

It is highly likely that, whatever the project chosen, there will be something already published which relates directly or indirectly to it. With some topics, for example, distribution of reef corals, or the biology of the Crown-of-thorns starfish, there is an enormous amount of relevant literature, and clearly it is impossible to trace or read it all. However, it is worth making every effort to find publications which relate both to the subject matter of the proposed project, and the locality which the expedition plans to visit. This part of the preparatory work requires access to a good reference library that keeps journals and books on marine biology. College, university and museum libraries are generally an excellent source, while Public Libraries and the National Lending Library will secure specific publications on request. It is worth scanning both 'Biological Abstracts' and the appropriate Journal(s) in order to find published papers relating to the project.

These, once located, are extremely useful because they provide invaluable leads not only to the work itself, but also to the people who have been doing the research.

9.3.2 Knowledgeable people

It is often tempting to by-pass the literature searches and try to go straight to experts who can provide useful background information, and perhaps comment on the expedition work plan. These people are often to be found in universities, research institutes, marine laboratories, museums, conservation organisations and naturalist societies. The Underwater Association has members throughout the world, and its membership list with addresses and the interests of the members provides a wealth of potential contacts. Once one contact has been made this generally leads on to others. The major problem is that these experts may not have endless time to spend on formulating ideas for expeditions!

It is highly desirable to make contact with the relevant educational establishments, laboratories and government departments in the country that the expedition plans to visit. It should be possible, in most cases, to obtain contact addresses from the country's representatives in London. The addresses and telephone numbers of all the Embassies, High Commissions, Consulates and Tourist Offices in London are listed in the London telephone directory. The British Sub-Aqua Club has branches in many overseas countries, and these usually have a wealth of information on sites, and diving conditions.

There are several reasons why overseas contacts are so invaluable.

a) It is important to communicate with local marine biologists and conservationists in order to explain the project and ensure that the work will complement, rather than conflict, with programmes that are already in progress in that country.
b) Local experts are likely to be able to comment on the overall feasibility of the proposed project and on essential details, for example, on the migratory patterns of species which it is hoped to study. They can also provide information on the best time of year for the expedition to take place (for example when the sea is at its calmest and clearest).
c) Relevant Government Departments can usually give information on development plans, conservation initiatives, fisheries, tourism and related topics, which may need to be taken into consideration when planning the project, and are essential for conservation-orientated projects.
d) Overseas contacts can advise as to the need for special permits to carry out underwater project work, and of any relevant conservation or other legislation which may affect the way the project is organised. For example, it may not be possible to do project work of certain types within marine conservation areas.

9.4 DRAWING UP A WORK PROGRAMME

A project is more likely to succeed in its aims if a projected, day-to-day work programme is drawn up. Careful planning at this stage will pay dividends later. It is a good idea to test equipment and methodology as far as is possible in 'home' waters. This saves valuable expedition time, and gives some idea of the problems that may arise. It is also essential, for most projects, to set aside the first few days of the trip to allow familiarisation with species to be studied during the expedition.

It is important to leave sufficient time in the work programme for writing-up results, sorting and identifying specimens and other essential tasks relating to the project.

9.5 POSSIBLE PROJECTS AND METHODOLOGY

There are two basic approaches that can be made for projects; to make studies of habitats and communities, or of single species. Sometimes a project can be devised that combines the two, for example by carrying out a general ecological survey, and investigating some aspect of the biology and/or distribution of a single species occurring within the area.

All marine biological projects require extended periods underwater while observations are made and data collected. More results can be collected with fewer problems if the work is restricted to shallow areas. Often, however, records from deeper water are required, and this has to be borne in mind when setting out the proposed dive/work schedules. For example, it is best to try and avoid doing time-consuming, quantitative work on transects at depth.

Projects can be planned as short-term, 'one-off studies, as part of a study that will require follow-up on other expeditions, or as a contribution to an established project or long-term monitoring programme.

It is extremely useful, when planning a project which entails making species records, to prepare check lists and/or sketches and coloured pictures of some, at least, of the species which may be encountered. Quite extensive notes can be taken underwater in sealed plastic bags, or on plastisised paper. Some identification books are now available in waterproof paper.

9.5.1 Ecological surveys

These entail studies of sublittoral habitats and communities, and can range from the study of large areas (for example, a group of islands), to discrete ecosystems (eg. a single patch reef), specific habitats (eg. the reef front) or micro-habitats (eg. coral head). The more broadly-based general studies are particularly suitable for areas about which little ecological information is available. For previously undived areas they are probably the best option, because there will be little information on which to base more detailed or complicated projects. These types of project can be invaluable in providing information about the natural resources of an area (eg. Swain & Hull, 1980).

A 'ready-made' ecological or conservation project for coral reef areas has been in operation for several years. This project, called 'Reefwatch' has been developed in order to gather information about the increasing threats to coral reef areas. The Reefwatch form requests basic information about the type and location of the reef, its degree of coral and algal cover, and the extent of any environmental damage. For those who are interested in undertaking more detailed studies, there are supplementary study cards available on request which are designed to examine reef populations more closely. Details are available from: Reefwatch Co-ordinator, Tropical Marine Research Unit, Department of Biology, University of York, York, YOI 5DD. Comparable UK-based projects are organised by the Marine Conservation Society (9 Gloucester Road, Ross-on-Wye, Herefordshire, HR9 5BU).

An essential part of any ecological survey is to investigate species and their distribution. This could entail studying the distribution of easily recognised species, of prominent or ecologically important species, or of all species. It is also necessary to investigate habitats, and the physical environment. There are several ways of obtaining the information, some of which can be begun before the expedition leaves. The following steps could usefully be followed:

a) *Study of charts.* A great deal can be learnt from bathymetric charts about the type, depth and extent of sea-bed to be found in the area to be visited. For example, charts indicate the position of reefs and outcrops, and indicate whether the sea-bed is sandy or rocky, its profile and so on. This information gives an idea of the distribution and types of habitat to be found in an area. They also indicate places where carrying out surveys might be difficult, for example, because of strong currents, or the presence of shipping lanes. British Admiralty Charts (which cover many parts of the world) can be consulted in specialist libraries, and can be obtained from: J D Potter, 145 The Minories, London EC3N INH.

b) *Study of aerial photographs*. Aerial photographs are also excellent sources of information provided that, when the photograph was taken, the water was clear, and/or shallow enough for sea-bed features to be revealed. Photographs can show quite clearly different habitat types, such as sandy back reef, profusely growing reef rim, isolated coral heads and so on. Again, this can be invaluable background information when planning an ecological survey, since it gives an idea of the extent and location of habitats which might be forming the basis for study. The Directorate of Overseas Surveys (Air Photo Library, Kingston Road, Tolworth, Surbiton, Surrey) may hold relevant photographs.

c) *Preliminary and general survey on site.* Some expeditions know in advance through contacts, previous expeditions or personal knowledge, the precise location of the species or habitats they intend to study. In other cases, when less information is available to the expedition, or when the intention is to survey a wider area, it is useful to organise 'spot-dives' or, if conditions are suitable, to use an underwater sledge (Erwin, 1977). Earll (1977) outlines methods suitable for surveying different areas.

d) *Mapping profiles on site*. If a fairly detailed investigation is being made into the ecology of a specific area, it is often productive to work along a line from shallow to deep, in order to study more accurately the distribution of habitat types, and the communities associated with them. If this is to be done, it is helpful to map the profile of the sea-bed along the line to be investigated. This can be done quite simply by laying a line along the sea-bed which is clearly marked at regular intervals (for details of this technique see Earll, 1981), recording depths at specific points, and then plotting the results on graph paper, and correcting for tidal variations. Alternatively, the line can be marked at known intervals with buoyant coded tags, and depth soundings taken with an echo-sounder at each tag along the line. This procedure can be inaccurate if the tags are pulled out of position by tidal flow, and care should be taken that they are aligned with shore markers for the transect.

e) *Recording the distribution of habitats and species.* This may be done in a variety of ways, for example, at 'spot' sites, along a compass course, traversing a particular zone (eg. along the edge of a reef, or the top of a wreck), or along a fixed transect line.

If the expedition has prior knowledge of what to expect at the site, they can come with species and habitat check lists already prepared. If not, or if there are difficulties in identifying certain species, it will be necessary to spend the first days resolving these problems. However, it must be accepted that in situ recording requires particular skills, and that some taxonomic groups are notoriously difficult to identify, even by experts. Photography is an extremely useful technique for recording details of species occurrence within habitats and at specific localities. The value of identification guides produced on waterproof paper has already been mentioned.

f) *Study of one or several species.* A project to study in detail some aspect of the biology of a single species offers many possibilities, and, as with ecological programmes can work effectively at different levels of intensity with emphasis on different aspects. Any species can be chosen, provided that:

(i) it is accessible.
(ii) it is present in sufficient numbers to sustain a sensible work programme and obtain sufficient data.
(iii) the work to be carried out does not conflict with conservation or other legislation.

In many cases a species which is either of conservation and/or commercial interest can be chosen. A species may be of conservation interest broadly for two reasons, often a combination of both. Firstly if t is considered a 'key' species in the ecology of the area (eg. the Crown-of-thorns starfish, the sea-urchin Diadema, certain dominant reef corals). Secondly if the populations of the species in question are known to be threatened in some way, either locally, or world-wide. Examples include black corals, precious corals, giant clams and turtles. Details of these species are given in the IUCN Red Data Books (eg. Wells et al, 1983).

If the distribution and ecology of a single species is to be studied, it is generally relevant to employ the same basic techniques outlined above for carrying out more broadly-based surveys. For example, the laying of a transect as a focus for the work. The potential for this type of study is illustrated in the nationwide investigation of the sea-urchin Echinus esculentus (Nichols, 1979).

Studies on the behaviour of individual species can rely on straightforward observation, or on manipulative techniques. There are considerable possibilities with either approach, and the latter lends itself particularly to people with an imaginative approach who want to attempt something a little different. One problem, however, is that a great many marine animals are sedentary creatures whose behavioural responses are not easy to detect in situ. This narrows down the types of animal that can be expected to provide 'results'. However, there are many possibilities, especially with fish (eg. Ogden, 1985, Wood, 1985), echinoderms (eg. Warner, 1985) and crustaceans (eg. Glass, 1985). Fish are probably the favoured group. However, even this type of project has to be approached with caution, since it is known that the presence of divers can themselves alter quite drastically the behaviour of the fish under study (Chapman & Atkinson, 1986). Some animals lend themselves to being tagged, so that individuals can be more readily recognised and followed from day-to-day. Again, this may require some ingenuity, and care must be taken not to damage the animal unnecessarily. Filming is an invaluable technique in studying the behaviour of animals, and a tape-recorder is extremely useful in enabling fast- moving events to be satisfactorily recorded. A simple tape-recorder for underwater use is described by Byers (1977).

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10

SCIENTIFIC COLLECTION TECHNIQUES

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10.1 INTRODUCTION

Collection of Specimens has been an important part of any biological or geological expedition for centuries. Today there is on increasing emphasis on conservation and many organisers of expeditions may feel loathe to actually bring back specimens. Worse still, some governments, especially in third world countries, have restrictions on collection of specimens even for scientific purposes. Nevertheless, if the aims of the expedition involve identification of animals, plants, rocks and fossils, then specimens will be required for study after the expedition has returned home. If your expedition is visiting an area where there are restrictions on collecting, then arrangements for any necessary permits should be made well in advance. Geological specimens are less likely to be subject to such restrictions and of course do not require preservation. Their collection will not be discussed further here. Photography can sometimes substitute for actual preserved specimens, but most groups of marine plants and animals are so poorly known taxonomically that this will be of limited use. Any taxonomist will want to look at a specimen if asked to identify an animal or seaweed.

The expedition's scientific leader will know what sort of animals or plants he is intending the expedition to study. It is probably not sensible to carry out general biological recording unless the team has specialists in all the groups likely to be encountered. In most parts of the world there are such a large number of species that it will be impossible to record or collect them adequately. Specialists generally have enough material of their own, and will not be interested in identifying mediocre material for anyone else. It makes more sense to have specialists in the expedition party to direct recording and collecting on site. They should have a clear idea of what will be done with the material on returning home. If the expedition members make contact with people in the scientific world who are studying particular groups, giving details of the area the expedition is visiting, then their needs can provide a focus for collecting activities.

Some expeditions are conceived primarily with exploration in mind, but the remote areas visited by such expeditions provide a unique opportunity to acquire material which should not be missed. In certain circumstances, for example cave exploration, the habitat is unusual, and almost any specimens will be of interest to biologists. In this situation it is normally possible to make contact with a scientist who specialises in the habitat under consideration, and seek advice in advance.

10.2 COLLECTING METHODS

There are as many methods for collecting biological specimens as there are different groups of animals and plants. Only some general principles can be covered here. The reader is referred to specialist publications listed in the references for further details. The Linnean Society synopses of the British Fauna often have good advice on collecting particular groups. Equipment varies from the simple to the complex.

Polythene bags are one of the best specimen containers for underwater use. The ideal size is about 12x18 inches and a heavy gauge is best (500 gauge is about right). Snap-top bags tend to have small holes at the corners and are rather thin, but in small sizes they are useful for collecting separate samples of organisms such as sponges. They can be numbered with a waterproof slate against these numbers. A record of micro-habitat, photograph numbers and details of appearance made at time of collection can then be linked with individual specimens afterwards. For quantities of seaweeds mesh bags of fine nylon material with a drawstring are preferred; seaweeds tend to float out of polythene bags. Individual small specimens can also be placed in small numbered plastic tubes held in a bandolier. This is a good method for small molluscs which may be easily lost or damaged if put into a bag with other specimens. Sea anemones are a particular problem as they tend to sting and kill other animals in the same container.

Most collecting by divers is carried out by visual searching. On rocky substrata this includes looking beneath loose rocks, in small caves and crevices and amongst sessile organisms. As well as collecting individual specimens by observation, it is possible to obtain numbers of smaller species by bringing up quantities of the algae, hydroids, bryozoans or sponges which cover rocks. This material can then be searched in trays on the surface afterwards. Small shelled molluscs can be washed out of quantities of seaweeds by immersing them in fresh water for 2 hours or more, which causes the molluscs to drop off the weeds. On sedimentary seabeds, it is important to recognise disturbances of the surface associated with burrowing animals. Another aspect of visual searching which should not be neglected is night diving. This is especially so in the tropics where many organisms hide in the coral by day and are only active at night. Many echinoderms, molluscs and some fish come into this category.

Photography of specimens in situ (before collection) is an important activity. Photography is dealt with in a separate section in this publication (cF. George). Collection of fast-moving animals, especially fish, presents problems. Traps, nets and spearguns may be used to catch fish; small crustaceans can be collected at night using a highly specialised light trap; burrowing animals may be collected by digging with a knife or trowel, but deeper borrowers may have to be excavated with an airlift. A simple airlift can easily be from a piece of plastic drainpipe 6-8 feet in length and a direct feed attachment on a regulator and spare cylinder. Airlifts have also been used for collecting quantitative samples of organisms on hard substrata, acting like a vacuum cleaner (Hiscock and Hoare, 1973).

10.3 HABITAT RECORDING

As well as collecting specimens, it may be important for a biological expedition to record the habitats which are present at each site. Several habitat recording forms are now in general use in the British Isles; the Marine Conservation Society has examples. MCS also run a project called Reefwatch which has habitat recording forms for tropical coral reef areas as apart of its package. Recording habitat information on a standard form has the great advantage of not omitting information that may be useful later.

10.4 FIELD NOTES, DRAWINGS AND PHOTOGRAPHS

The value of a specimen to science will be greatly increased by careful documentation. Information concerning its locality, depth, habitat, etc. must be recorded at the time of collection. If more than a little casual collecting is being carried out then the best way to record such information in the field is to give each specimen a label with two numbers, a site number and a specimen number. At the Ulster Museum, we use a dive-site number consisting of the date, in reverse order, and a running number. This number links specimens with locality and collector, eg. 840615/02 for the second site on the 15th June 1984. The locality, latitude and longitude, collectors, depth and habitat parameters are then recorded under this number in a field notebook or on special recording cards. After the expedition, this information forms the basis of a station list. The other information, such as photograph numbers drawings or field notes for individual specimens, are linked to the specimen by a unique specimen number. I have used codes such as BEPHK./15 etc. in this case for the 15th specimen collected in Hong Kong. A label written in soft pencil on good quality rag paper is then written, bearing just these two codes, and put into the preservative with the specimen. This is an easy system to operate in the field, and prevents important information concerning the specimen from being lost or confused.

With some groups of animals, for example, my own specialty being nudibranch molluscs, it may be important to make detailed drawings and notes, and to take close-up photographs, before preservation. The preservatives used for marine animals generally result in loss of natural colours. If this is not allowed for, then information of great value to the specialist may be lost. There are several species among the well-known British nudibranch fauna where a sketch with some basic notes on colour is sufficient to confirm an otherwise difficult identification. If taxonomy is less complete and poorly known species will be encountered, then observations on living specimens may add considerably to our knowledge.

10.5 PRESERVATIVES AND PRESERVATION

Biological material is preserved in a variety of ways. Most marine animals are normally fixed and stored in a liquid and transport of such material by air is a problem. Algae are normally preserved as herbarium specimens dried on sheets of herbarium paper and are much easier to deal with. Several books are available which deal in detail with the preservation of different animal groups, (eg. Lincoln and Sheals, 1979). Most preservation can be carried out with a limited range of chemicals if transport is a problem. Formalin is one of the best general purpose fixatives. It can be transported as full-strength solution and diluted when required to a 10% solution in sea water. Dowicil is a solid preservative which works by producing formalin when in contact with animal tissue. It is used as a 10% solution and is particularly suitable for expedition where there is difficulty in transporting formalin. Many marine invertebrates need to be narcosed before preservation. A 7% solution of specimens of Magnesium Chloride mixed 1:1 with the sea water containing the specimens is effective for most animals within 2-6 hours. Solid Dowicil and Magnesium Chloride can be weighed out into packets sufficient to make one litre of solution and then mixed with water on site. Ideally specimens should not be left in formalin for more than a day or two, as formalin solutions tend to become acid unless buffered. If the animals have calcareous shells or skeletal structures, this can be a problem. It is best to transfer specimens to 70% alcohol for storage as soon as possible. At the end of the expedition, it may be possible to pack the specimens in very little preservative for transport as long as they are properly fixed in the first place.

10.6 STORAGE AND TRANSPORT

A large number of specimen containers tend to be very bulky. If it is at a premium, as is normally the position on expeditions, then careful consideration of the various options for storage and transportation of specimens is important. A method I have frequently used effectively is to put the specimens into snap- top plastic bags in buckets of fixative and preservative. Individual specimens are placed in a bag with a label (after narcotism if necessary) and the bag filled and immersed in a bucket of preservative. This is the most compact way of storing numbers of medium sized specimens. Small and delicate specimens such as amphipods and many molluscs may store better in small separate stoppered tubes for liquid preservatives, as they are far less prone to leakage.

10.7 CONCLUSION

At the present time many parts of the world's oceans are being explored by divers for the first time. Man is exploiting and damaging these places at a hitherto unprecedented rate. Organised scientific collection will not damage marine ecosystems if carried out in moderation and is essential to our understanding of the animals and plants which live there. Responsible collecting has a place in the activities of most expeditions.

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11

UNDERWATER GEOMORPHOLOGY

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11.1 INTRODUCTION

The term "underwater geomorphology" will be interpreted to include all aspects of geology, landforms, geological processes, and dynamic processes which occur on the seabed or at the shoreline.

Divers have conducted research in numerous aspects of underwater geomorphology, including coral reef formation and erosion, bed-rock outcrop studies, igneous and volcanic processes, sediment transport, sea bed coring, studies of erosional forms such as caves, pinnacles, terraces, and drowned river valleys, study of submerged peat and lagoon deposits, sediment micro-processes such as ripple and sand ribbon formations, studies of drowned topography and soils which relate to submerged Quaternary landforms. An early review of this field was provided by Flemming (1971).

In this paper I will discuss briefly methods of work, with references to the principal publications.

11.2 SHORELINE PROCESSES

Some of the principal work employing divers in shoreline studies has been conducted by researchers at the Coastal Processes Laboratory, Scripps Institute of Oceanography, headed by Professor D Inman, 1959; Inman et at., 1981; Inman and Dingier, 1977).
Seabed intervention has been used for the installation and recovery of wave recorders and sediment traps in the nearshore zone, as well as for direct visual observation of sediment movement, and bedforms. In Australia the group at Sydney University, lead by Dr Andrew Short has developed techniques for measuring wave and sediment processes in heavy surf (Short and Wright, 1984). At the Institute for Oceanographic Sciences, Taunton, England, John Moore and others developed stereo-photogrammetry methods for studying the movements of sand waves and ripples with time-lapse photography and TV. In Israel, Victor Goldsmith has used diving observation, dye tracers, and instruments to measure near-shore currents in and near the surf zone.

The common factor in most of these experiments is the need to work in the highly mobile and turbulent near-shore zone, or actually within breakers or plunging surf. This obviously requires a high degree of safety planning and control. The methods for working in heavy suit have been most completely documented by Andrew Short, and are outlined in the CMAS-UNESCO International Code of Practice for Scientific Diving.

Navigation and position fixing is simply an extension of shore-based methods. Instrumental methods include depth sounding with poles or tapes, distance measurements with tapes or wires, velocity measurements, suspended sediment measurements, beach profiling, tracking sediment movements with labelled tracers, bedform studies, measurements of the rates of movement of bedforms with currents, waves, and tidal cycles, and coring and sampling of sediment stratification, and various applications of video and photographic systems.

11.3 NEARSHORE AND OFFSHORE SEABED STUDIES

Divers have studied a number of interesting subjects in shallow water not related to the shore zone, and further offshore (Dill, 1964; McMullen and Alien, 1964; Eden and Carter, 1969; Keller, 1977; Akal, 1985; Giermann, 1985). Many lagoons, estuaries, and shallow embayments and geochemical processes in the sedimentary column have been studied. Research projects by Dutch and American scientists have included sampling programmes using cores obtained by divers. Further offshore, the study of seabed rock outcrops has been used in many countries to extend the geological maps. Michael Max (Max and Cathcard, 1978; Max, 1978) has used this method extensively around Ireland, and on one occasion with French colleagues (Lefort et at., 1980). The British Geological Survey used divers in this way (Flemming and Binns, 1974), and other projects have been carried out by Durant et al. (1980). At the University of Clausthall Zeilerfeld in Germany, there is a full time diving geology programme, headed by Professor K.laus Muller, and several reports have been published from their annual symposia. Antonio Stefanon has used diving to investigate outflows from submarine springs (Stefanon 1984), whilst Paolo Colantoni has scuba diving and oxy-helium mixed gas diving to map igneous rock outcrops on deeply submerged banks in the Mediterranean to depths of about 100 m. (Colantoni, 1980).

Equipment includes rock corers, drills, inclinometer, photography, video, and ship-borne survey systems such as echo-sounding, side scan sonar, and shallow seismic profiling. Efficient survey navigation is needed, since the vessel is often many tens of kilometres from shore.

11.4 SUBMARINE CAVES

I will say nothing about submarine cave surveys, since Rob Palmer is the expert. Nevertheless, it is important to stress that exploration and study of these caves is a branch of geology and geomorphology.

11.5 QUATERNARY LANDSCAPES

During the Ice Age (approximately the last 2 million years), the sea level rose and fell through about 100 m approximately 20 times. The entire continental shelf of the world has therefore been exposed alternately to marine processes and subaerial processes with a periodicity of about 100,000 years. What divers actually see today on the sea floor is a palimpsest of submarine and terrestrial landforms. The most obvious indications of this are submerged cliffs, sea caves, rock-cut terraces, erosion notches, beach ridges, and other features obviously connected with submerged fossil shorelines. These features have been observed as deep as 90 m. (Flemming 1972). Study of submerged Ice Age topography and landforms has been carried out by Ellik Adier for the coast of northern Israel (1986), and by Flemming (1972) and Flemming and Webb (1986) for several parts of the western Mediterranean. Van Andel and Shackleton have recently shown how surface oriented acoustic surveying techniques can reveal a wide range of submerged terrestrial features off the coast of Greece, but their presumed landforms were not checked by diving. It would be interesting to do so. Flemming (1986) reported a survey of submerged terrain off the north coast of Australia.

11.6 CORAL REEFS

I am not an expert on coral reef geomorphology, and divers most commonly study the biological aspects of reefs. However the cumulative effect of the growth of coral reefs is to change the geological balance of the crust of the earth, adding enormous volumes of calcium carbonate. The study of these carbonate reefs and platforms has been carried out by divers, and the results have been published by Thorn, Shinn et at. The principle areas if research confirm long-term rates of accumulation, effects of storms, and sea-level changes on the gross structure of reefs and the physical processes of down-slope transport of coral rock debris.

11.7 VOLCANIC AND IGNEOUS PROCESSES

The study of these processes is a very esoteric activity, but a small number of intrepid divers have studied and filmed the movement of hot molten rock underwater. This is not merely bravado, since large quantities of volcanic rock are emitted underwater, and the interaction of the rock with the water determines both the final form of the rock and the chemicals which dissolve into the ocean. Notes on working techniques occur in the forthcoming UNESCO- CMAS International Code of Practice for Scientific Diving.

11.8 CONCLUSION

Geological and geomorphological diving is not as widely practised as biological or archaeological diving but it has been very effective. The best general bibliography is obtained from the CMAS Symposium Series, from which an extensive bibliography can be traced back into the mainstream geological literature. Techniques are usually a direct extension of land-based geological methods combined with a adaptations of survey and recording methods.

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12.

OBSERVATIONS ON THE DIRECTION OF UNDERWATER ARCHAEOLOGICAL PROJECTS ABROAD

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12.1 INTRODUCTION

These notes are directed at people who are contemplating leading a maritime archaeological expedition abroad. On all points I have tried to be frank and honest. My bias is towards competently staffed expeditions under qualified leadership, which, through scientific publication, will advance historical learning and enhance the image of wreck investigation as a valid and necessary sub- discipline of archaeology. The topics raised here all deserve chapters of their own; my difficulty in these few pages has been to take complex, abstract and sometimes subjective issues and crystallise them into a few simple sentences.

The thoughts and observations expressed here are based on five years of experience as a director of underwater archaeological work in the Mediterranean for the University of Oxford; work which in 1984 led to the formation of Oxford University MARE, the first academic unit in Britain to specialise in the excavation and study of ships from antiquity. The approaches and diving procedures described here are those of Oxford University MARE.

In this paper I do not dwell on the actual techniques of underwater survey and excavation - these can be found in handbooks. Nor in these pages do I distinguish between "underwater", "maritime", "marine", and "nautical" archaeology. Discussions on the fine shades of inference between these terms I find tedious and pedantic.

It goes without saying that in all underwater activity, the foremost consideration is safety, but I will not clutter these paragraphs by stopping to qualify everything I say with provisos regarding correct diving procedure.

12.2 ETHICS

Although underwater archaeology is taken more seriously than it used to be, it is still true to say that it suffers from an image problem: the ill-informed see it as fun-in-the-sun; the informed, quite correctly, point to the discipline's record of scientific publication which, by the standards set by our colleagues on land, is generally shamefully inadequate. It is important that anybody considering an underwater archaeological expedition asks himself two questions: why do I want do this, and, am I qualified?

If what you are contemplating is an expedition for an expedition's sake, with a rather aimless set of archaeological objectives, which you hope will give your diving a purpose, and your expedition an aura of credibility that will look good on paper, then, for goodness sake, direct your energies elsewhere, for in the long run, with these motives, you will surely do harm to the discipline, and make the task harder for those who are attempting to raise the level of respectability of maritime archaeology through genuine scientific achievement.

Your desire to mount an underwater archaeological expedition should stem only from an honest commitment to archaeological-historical learning. Any glamour that you perceive as being attached to underwater archaeology will melt away quickly, and then what is left is just sheer hard work which will require of you almost pathological dedication and the willingness to sacrifice all leisure.

In broad terms field archaeology is all about new information and it is the archaeologist's duty to disseminate this at a scholarly level through publication. To not do so is the height of irresponsibility. It is an old adage of archaeology, and one certainly worth repeating, that all excavation is destruction. Whether on land or underwater the very act of excavation destroys. A site, once excavated, is gone forever, so that it is therefore imperative that the findings and research resulting from the work be published, for otherwise the accruing information will remain banked in the mind of one individual and will be lost upon his decease.

For these reasons I am even reluctant to encourage the amateur organisation of light survey expeditions, which plan in the course of their survey to remove artifacts from the seabed. In the sixties and early seventies there were many such expeditions that perhaps might be better described as "amphora gathering safaris", in which, in the name of archaeology, ancient harbours, anchorage sites and even wrecks were stripped of everything that was visible. Very little of a serious nature was ever published, and these sites have now been altogether expunged, or had their surface detail erased, thus preventing, or complicating, any serious remedial investigative work today.

The only underwater expeditions, that comes to mind, in which amateur expeditions, without the leadership of an accredited archaeologist, can possibly benefit archaeological learning, are those which involve the mapping of underwater features, such as fisheries and sunken walls. In activities of this nature the work is non-destructive, so that if the leader fails to publish adequately, the work can be re-attempted at a later date by somebody else.

From the above I hope it is clear that underwater archaeology is not for dabblers, or unqualified but well-meaning enthusiasts. Like a land excavation, an underwater archaeological expedition is an activity requiring a team with a highly qualified and experienced staff. The remainder of this paper is directed at those who are serious in their intent to enter the field with such a staff.

12.3 TEAM COMPOSITION

There can be no such thing as a perfect team, but by careful team selection one can come close to it. In what follows, I take it for granted that the director or leader is a qualified and experienced diver. Fig. I shows the Oxford University MARE team structure.

12.3.1 The Director

Fortunately, the days when maritime archaeological expeditions could be led by non-archaeologists are, it seems, almost over, but the expertise of archaeologists is variable and it is disturbing that in recent years there have been expeditions led by people who have no more than a freshly obtained first degree in archaeology (or not even that) to qualify them for the task. On land such people would rarely if ever be entrusted with the directorship of an archaeological site. A person who is still studying, or who has just achieved their first degree, and who is without a broad background of practical field experience, is unlikely to be adequately qualified to direct an underwater excavation.

A director's credentials should demonstrate that he or she has considerable practical experience, sufficient scholarly training, and is capable of publishing to an acceptable standard. Let me take these points in order.

12.3.2 Practical Experience

It is imperative that the expedition leader has gained a wide experience on other reputable teams so that he is familiar with excavation techniques and methodologies, recording of finds, conservation, safety procedures, logistics and mobilisation, provisioning, etc. In my view - for others may dispute this - it is highly desirable for the director to have had a broad experience on terrestrial sites. The quality of the work of underwater archaeologists who have had a landed background would seem to argue this for me. If one thinks of the most respected names in underwater archaeology it will be seen that the majority have dry-land experience as a common denominator. The painstaking patience, the attention to detail and the discipline that are needed to decode a terrestrial site provide the best training, and frame of mind for underwater survey and excavation.

From work on land, one should then proceed to acquire experience on underwater sites that are directed by accredited underwater archaeologists. Serious underwater archaeology cannot be organised and run like club diving, therefore it is necessary that a potential director should see at first-hand how his experience at club level can be adapted to suit a working underwater archaeological programme. Furthermore, it is only through practical experience that a future director can acquire familiarity with the wide variety of applied skills that are required on an underwater archaeological team. For instance, the director does not necessarily need to be an expert photographer, but he must be able to discuss the requirements of photography with the camera-man - as well as draughting with the draughtsman, conservation with the conservator, food with the cook, equipment with the mechanic, boats with the boat-handlers, book-keeping with the treasurer, and of course archaeology with the archaeologists. For the person who is contemplating underwater archaeology as a serious occupation, I would recommend, as a bare minimum, three summers of prior experience with other teams.

12.3.3 Academic Background

Apart from practical experience, a director must also have a background that is firmly rooted in study. It is axiomatic that if one is planning to become seriously involved in field archaeology one should have studied history and archaeology at an advanced or University level. University level study will, in addition, help give one a clear perception of the scholarly responsibilities involved and provide certain theoretical skills which are indispensable for directing both landed and underwater archaeological projects.

The range of skills that any future director can acquire at university are many, but foremost amongst these is the ability to interpret pottery. All the wrecks from antiquity that I have seen - and they number over thirty-five - were characterised by pottery spreads, usually of coarse ware (see Figs. 2,4 and 5). Everything else from a wreck, including the hull, may well perish, but the pottery, because of its durable nature, will survive. Ninety percent of the time, the director's working chronology will be indexed to the pottery, and more often than not, it will be the pottery that tells him what he has found, and guides his priorities and how he deploys his team.
Remarkable as it may seem, there have been expeditions from this country which had nobody on the team capable of evaluating the pottery raised. In other words there was no way of reading the site or assessing the archaeological value of what was seen. Such a situation is farcical and would never be tolerated on land.

Another skill which a future leader or director should have, is an understanding of the fundamentals of ancient ship construction. In the case of a well-preserved wreck site that is encapsulated in a soft seabed, the director must be able (in so far as it is possible) to identify any items of structure that may appear. As with the pottery such people are not found easily.

Here I have dwelt on just two academic skills, pottery and ship construction, but it should now be evident that the underwater archaeologist has to be versatile and wide in his knowledge, rather than narrow and deep. The intellectual skills with which a person seriously interested in underwater archaeology must equip himself, can only be obtained through hard study.

Those people who lead underwater expeditions without adequate scholarship behind them, tend, if they publish at all, to produce padded papers, which are long on dive statistics, and incidental descriptions; but short on real archaeological content and data. Archaeologists see through this immediately, and archaeologists, it must be said, have long and cruel memories when it comes to publication. One of the foremost qualifications of any prospective expedition leader is, I believe, a proven ability to publish well. Most experienced field archaeologists are sufficiently learned to assess and interpret their findings, but fewer are able to summon up what is needed to find the time, or self-discipline, to sit down and account for the work on paper.

Summing up: leading an underwater archaeological expedition or excavation is not something one rushes into on whim; it is important first to have gained practical field experience, developed the necessary intellectual resources and learned how to contribute to archaeology through serious publication.

It is important for a novice director to accept right away that there will always be problems (equipment, personnel, money, public relations, etc.,) and it will seem at times that one is not so much an archaeologist, but a co-ordinator in a survival game in which you just blunder from one problem to the next. A director must, in advance, adopt a philosophical attitude to these problems, otherwise they will, bit by bit, wear him down, and wring from him every last drop of enjoyment in the archaeology. If a director allows himself to become irritable and tense there is a danger that this will permeate the team.

It is equally important that the staff adopt a similar philosophical and flexible frame of mind for in the confined, pressured, and exhausting environment of underwater archaeology abroad, things can become distorted and out of proportion. For instance, I have seen two draughtsmen almost kill one another (or so it seemed), for the sake of a pencil, and another reduced to tears because her bed had to be moved to another side of the room, and others in a similar state from the frustration of losing a T-shirt, or not being able to put through a telephone call. Also, on expeditions, people's personal habits can be a source of irritation to some in a way that would not bother them at home. A heavy snorer for instance, can soon find himself given the leper treatment.

Over time a team may grow in size and professionalism, but do not think for a moment that your problems dissolve; it means simply that you have traded in one set of problems for another, which although more sophisticated will be just as troublesome, if not more so. When Oxford University MARE was entering the field for the first time the kind of problems with which we had to contend were of the order of not having enough knives and forks to go around, or enough containers for fresh water. At the time these difficulties seem crushing. During our most recent season, by contrast, our main problems were finding a spot to land a helicopter; trying to obtain a crane strong enough to lift a five ton road compressor on to a boat (Fig. 7); sorting out how to maintain charged batteries for our ROV (remote operated vehicle); preventing our recompression chamber from over-heating in the sun, trying to find shelter and anchorage for our research vessel during a force 9 gale, etc.

The worst problems are usually those which have to do with personnel. With regard to this a director must steel himself in advance to make the difficult as well as the unpopular decisions. It does not matter how carefully you vet the new applicants, there will always be somebody who is not prepared for the hard work and group responsibility that is involved in underwater archaeology. If their tour is short, you can usually let them complete their time without it having a serious effect on team safety or morale. With a big team, over time, there will however be odd occasions when a person will have to be dismissed during his or her tour for the sake of team safety and welfare. Take these decisions in consultation with close staff, and always make sure that one of them is present as a witness when the person is being dismissed, for you can never predict what direction events will take. Do not be surprised if, during the year, you hear that the person in question does not want to come to back for a variety of reasons that usually have to do with you, the staff, or the organisation, for such excuses are a necessary function of face-saving, and this should be understood even expected.

With team members who are on their first tour, it is perhaps wiser to try and keep a little distance between them and yourself, so that if any hard decisions have to be made regarding them (and this nearly always happens during first tours), then they can be made without the interference of sentiment.

As you grow in experience you will, below staff level, tend to keep all team administrative and policy matters on a-need-to-know basis. Nobody will ever agree with you on this but then nobody will have your experience of the way you will be cautious in what you say, and for every decision you take, you will have, in your mind, a set of alternatives. Although you learn to behave this way for the general welfare of the project and the achievement of its objectives, nobody will ever understand this other than another director.

A responsible director will soon become highly sensitised to all detail regarding diving safety. If you have a big team and long seasons, then you will be making probably well over a thousand dives a year. The statistics for diving incidents, you will soon realise, are not on your side, and so you become hypercritical about such matters as standby diving, time-keeper control, dive discipline, and so on. The majority of the team will see this as over-reaction, and this you will have to accept, for again, nobody other than another director will understand how the obligation of team safety can weigh so heavily upon the mind.

In the briefs try always to give credit for a good piece of work or a useful idea. Although in the broad scheme of things it hardly matters who, for example, first propounded an idea, it is as well to remember that, in the upside down world of excavation life, to that person it matters overwhelmingly.

Figure 2 Almost all ancient shipwreck sites are marked by intact or broken amphore. These great earthenware jars were the transport containers of antiquity. Different places evolved different forms, so that through the study of amphora shapes and chronology one is able to date wrecks and speculate upon their origin. The above is a Dressel 2/4 amphora from the sea off Marsala, Sicily (1983 season).

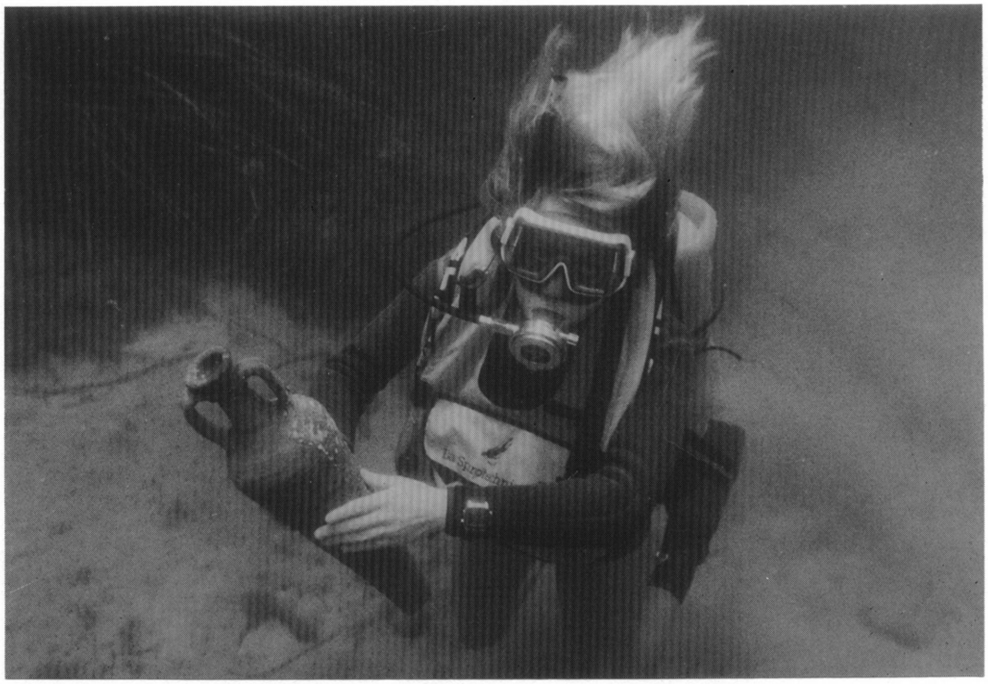


Figure 5 Not all amphorae can be identified. The origin of this miniature amphora carried by Joanna Yellowlees is unknown. (Marsala 1984).

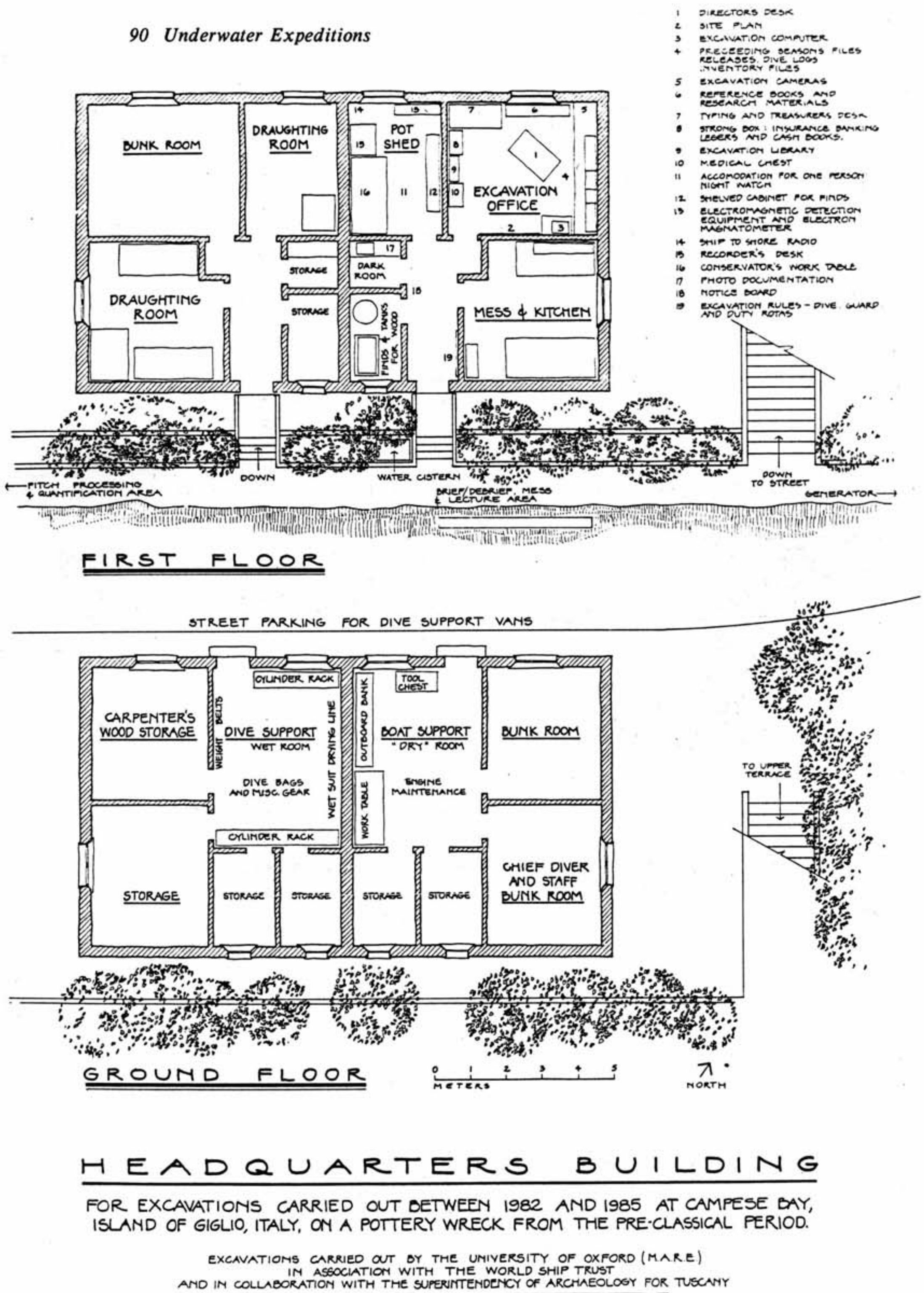


Figure 6 Accommodation is a big worry for any director. This diagram shows how Oxford University MARE arranged its working quarters on Giglio from 1983 - 1986. Another building of equal dimensions was used for sleeping. (Drawing by Dick Hill).

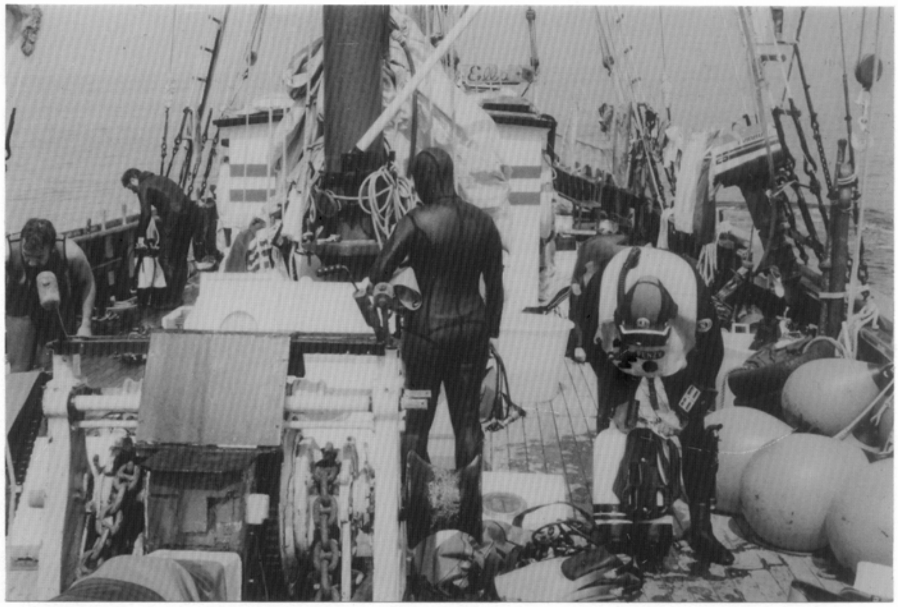


Figure 7a Oxford University MARE team preparing for a dive off the Island of Gianutri. Plenty of deck space is essential for any boat beig used in archaeological diving.

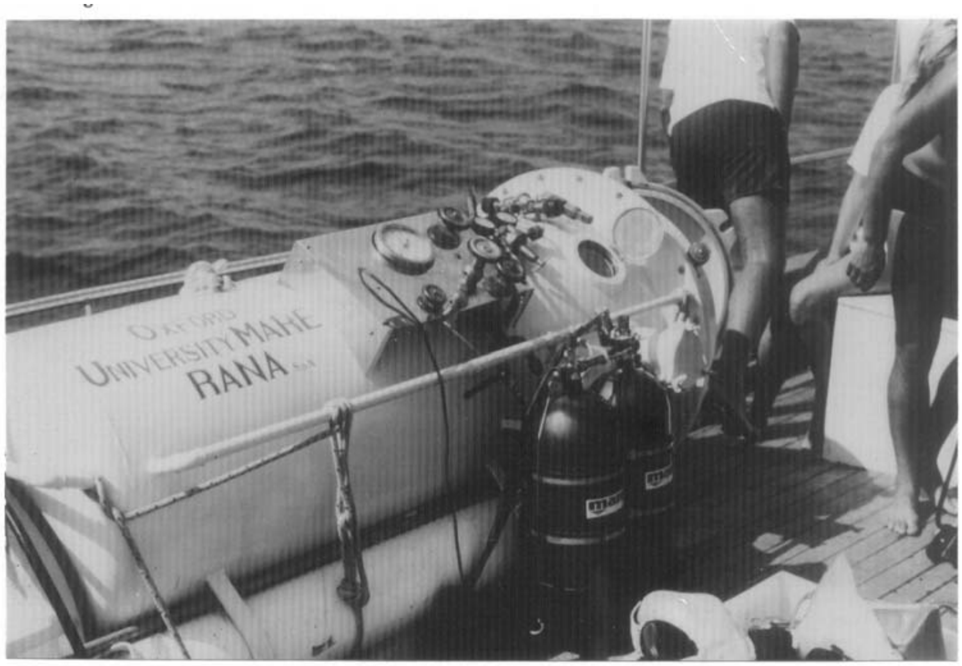


Figure 7b A recompression chamber is a big asset, but it must have a trained operator. project

Most of the ideas that are put to you in the briefs you will have heard before - many times. The majority will not work. Try to be kind in your response, if the idea is wildly impracticable, do not say so, but instead say something like, "The idea has merit but....". If the idea is just downright bad, say it is bad "in a way that has value"; and so on.

There are certain ideas that, like the swallows to Capistrano, reappear every year without fail. On the surface they seem to have unassailable logic, which makes it almost impossible for you to convince a team that they will not work. The best and cleanest way out of this situation is to suggest that the idea is tried for, let us say, a week, after which the situation will be critically re-assessed. Give it to the person who proposed it to implement. At the end of the period the idea will be dead and forgotten and nobody's feelings are hurt. If you are wrong and the idea works then the whole projects benefits. In excavation politics, knowing when to dissemble and "stonewall* is as important a part of the director's craft as is knowing when to be frank and decisive! In general you will probably find that the direction of large scale underwater operations abroad, and everything that it involves, stretches you in all directions and in such a way as to bring out the very worst as well as the very best in you.

A director must learn also how to keep discussion in briefs and ad hoc meetings to a minimum, for there is a syndrome which I have called elsewhere "the endless art of admiring the problem", which wastes hours and is deadly for the achievement of results.

12.3.4 Chief Diver

A multi-season, underwater archaeological operation depends for its success on the quality of its paperwork at home and that of its chief diver(s) in the field.

By paperwork I mean scientific publication, preparation of drawings, accounts, audits, minutes of meetings, fund-raising, insurance, correspondence with sponsors, scholars and technical assistants, and the task of processing and vetting the numerous applications that are received from people wishing to join the team.

By chief diver, I mean the person who is responsible for organising the diving, as well as implementing all decisions of a practical nature, and keeping the director informed about the state of equipment and other such matters. Since the director of a big team usually has to be involved deeply in the archaeology and the co-ordination, the act of molding the team into a fat-free and efficient diving unit falls to the chief diver, and because of this some of the responsibility for team safety must also devolve on him. The selection of a chief diver is then an important matter.

In order to operate efficiently, Oxford University MARE, as with several other large teams, requires about eight chief divers. In underwater archaeology, the major expenditures occur during the mobilisation and de-mobilisation phase of the programme. Once in the field operational expenses diminish, thus making it more cost-effective to have long seasons. Long seasons, however, tend to exhaust divers, especially in hot climates, and so in recent years we have favoured "tours" of not more than two or three weeks for each member including chief divers, who, because of their responsibility, are under more strain than anyone else. This works well because most MARE members are skilled technicians in some form of employment and thus only have two or three weeks holiday to spare. This means that not only is there a constant turnover of divers during the season, but also of chief divers.

Furthermore, we find it advantageous to have several chief divers on the team at any one moment. In an ever-developing programme such as that of Oxford University MARE it is always wise policy to deploy a small detachment on the survey of possible future sites, while the main body concentrates on the principal project. This yields vital information at little or no extra cost, which helps you to decide how best to spend time, money and resources in the future for maximum archaeological return. Such subsidiary projects require their own chief divers.

Since most people, including chief divers, will not be with the team for longer than two or three seasons, the search for new chief divers is continuous. Divers are not promoted to chief diver until they have completed at least one tour and then they will spend time as assistants to the chief-diver-in-charge before being given the responsibility for organising. Nobody should ever be made a chief diver solely on his experience and expertise as a club diving officer or dive marshal.

A person who has spent all his diving life working to club patterns requires time to concede that there are other ways of diving, to adjust to the needs of working archaeological dives, and to glean some understanding of archaeological theory. A person is promoted to chief diver on his merits as a diver, on his ability to organise and run safe, disciplined diving, and for his previous experience of underwater archaeology. It helps if a chief diver has a gut feel, or instinct, for archaeology, but this is usually one too many qualities to ask for, and so should be regarded as a bonus, and not a rigid criterion for selection. Most of the best chief divers we have had - although several notable exceptions spring to mind - were not good archaeologists, but this never compromised the quality of the archaeology as long as the relationship between the director and chief diver was good.

A reliable second opinion, or appraisal of the state of the archaeology, at any one moment, can usually be had from several others on the team who have an excellent archaeological sense, and whose views you have grown to respect, but who do not have the leadership qualities and practical skills that are essential for a chief diver.

In many ways the most important criterion in the selection of a chief diver is the state of his relationship with the director, for it does not matter how skilled and experienced he might be as an archaeological diver, if he cannot get on with the director then it is impossible for him to function properly as a chief diver. The importance of good communication and compatibility between the director and the chief diver cannot be over stressed, for without it, it is only a matter of time before the archaeology and team harmony begins to suffer, and this, of course, is unacceptable. The director and chief diver working well together is a powerful combination for the good of the project, but when things between them go wrong or become stale, there has to be a reshuffle of the team hierarchy.

To minimise the risk of tensions arising between the director and chief diver it is best to select chief divers as much on a basis of temperament as on diving skill and experience, and then speaking frankly with them of the dangers of rifts occurring, so that they are on their guard, but also in the event of a rift, aware of the director's narrow options.

Top-rate chief divers are hard to find and, because on our team we need so many, it is inevitable that the degree of excellence between them will vary. The best can work with an absolute minimum of supervision from the director, but many who are less experienced, need guidance, moral support, and constant watching in case safety standards should slip.

Some Scandinavian teams break down the chief diver's duties into two, so that there is one person, the chief diver, who is responsible for diving; and another who is responsible for all other practical matters except the act of putting people in the water. I am slowly coming around to the opinion that this is perhaps a better way of working.

12.3.5 Draughtsmen

In many ways the draughtsmen are the most important people on the team, for as I have observed before, the whole purpose of the project is new information, and that information must be disseminated fully in an intelligible manner; this means accurate technical drawings. A good drawing conveys far more information than a photograph (Figs. 8 & 9). The latter is good at giving a sense of reality and texture, but at best, it will conceal key information, and at worst, mislead. As a general rule, photographs should be considered as supplements to the drawings and not the other way round. One cannot even begin to imagine the kind of questions that will be put to the finds by the archaeologists of a hundred years from now and, therefore, one must aim at a full rendition of the detail; this can only be achieved with the aid of good, expositive technical drawings.

Good draughtsmen are hard to find, but nonetheless at the height of Oxford University MARE'S work on Giglio, we managed to put together a drafting corps of six professionals. Archaeological draughtsmen are almost impossible to enlist for they have spent their whole year drawing archaeological artifacts and therefore have little wish to spend their holidays doing the same. There are, however, other professional draughtsmen, such as surveyors, architects, illustrators, etc, who are keen to join archaeological expeditions, and who, with guidance, can redirect their skills to pottery or items of ships' structure in remarkably little time.

In our excavations we drive ourselves hard for what we call "100 per cent information", which to us means having every artefact recorded and every diagnostic piece drawn. This is an ideal at which most excavations working abroad aim, but which few, if the truth be known, ever achieve. On our team, everything must be committed to paper while the season is still in progress for, unlike the team that works at home, the archaeologist abroad cannot afford to return during the off-season to complete drawings for which there was not time while in the field. Not only would this be expensive in terms of travel, hotels and meals, but it would also be exorbitant in terms of academic time, a factor which is as much on the archaeologist's mind as money.

Towards the end of the field season the pressure starts to build inexorably on the draughtsmen. At this stage we give them "more-favoured-person" status, which means that they are excused from all other duties such as cooking, dish-washing, compressing, etc, but in return they are expected to work longer at the drawings. To avoid ill-feeling it is always wise to explain to the team early in the season that, in order to maximise productivity and achieve our goals, it is necessary later in the season to excuse the draughtsmen from all chores and rotas (Fig. 10).

It is wise policy to allocate a large room for the draughtsmen where they can lay out their instruments and work in peace. The team should be discouraged from talking or otherwise distracting them. A good drawing requires thought and concentration and this cannot be given while team members are constantly entering the draughting office to chat and see what is happening.

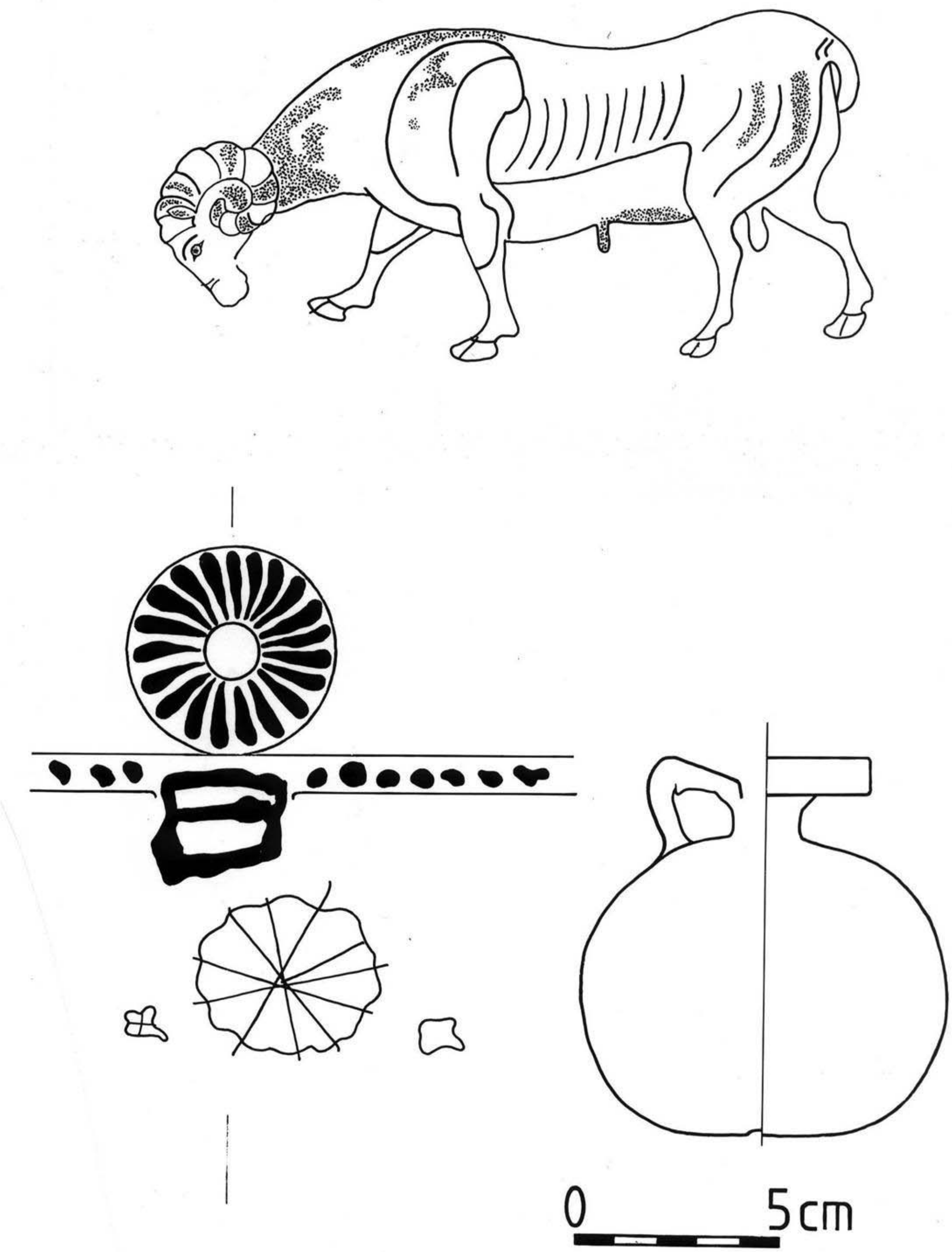


Figure 8 A drawing of a small painted Greek oil pot (arybollos) from the Giglio wreck c.600 BC. The pot has been drawn using the technical instruments; the animal has been traced.

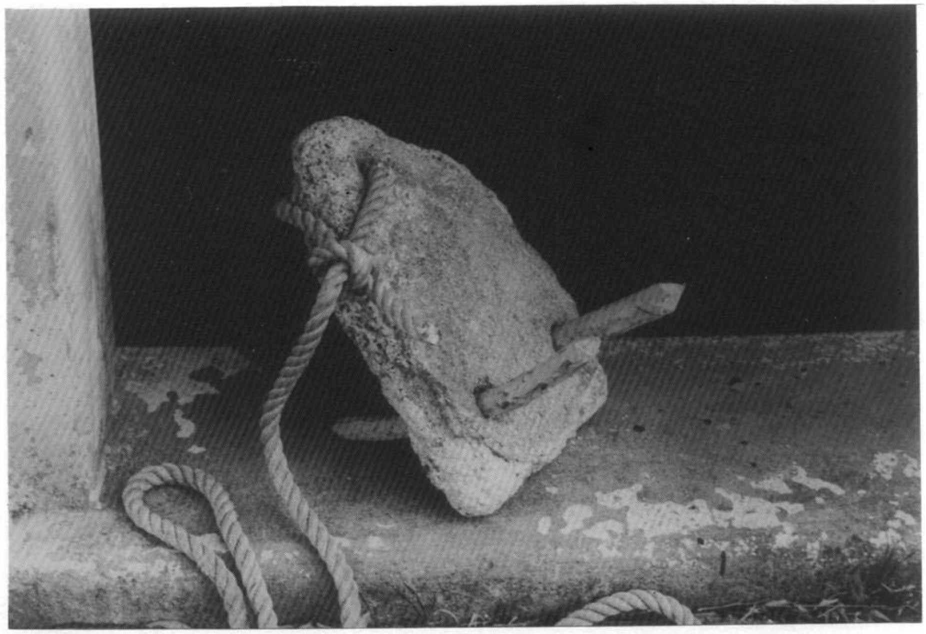


Figure 9a Stone anchor found at Marsala in 1984. The two wooden 'flukes' and the rope have been added to give an impression of what it was like when in use. (see figure 15).

Figure 9b A Roman lead anchor stock raised from the sea by the Oxford team off the Island of Panarea in 1987.

Figure 10 Skilled draughtsmen are a vital part of an archaeological team. In this picture we see three of Oxford University MARE'S draughtsmen at work in the makeshift field drawing-office. Left to right: Hugh Morrison, Sue Wikison, Chris Chapell (photograph Paul Arbiter).

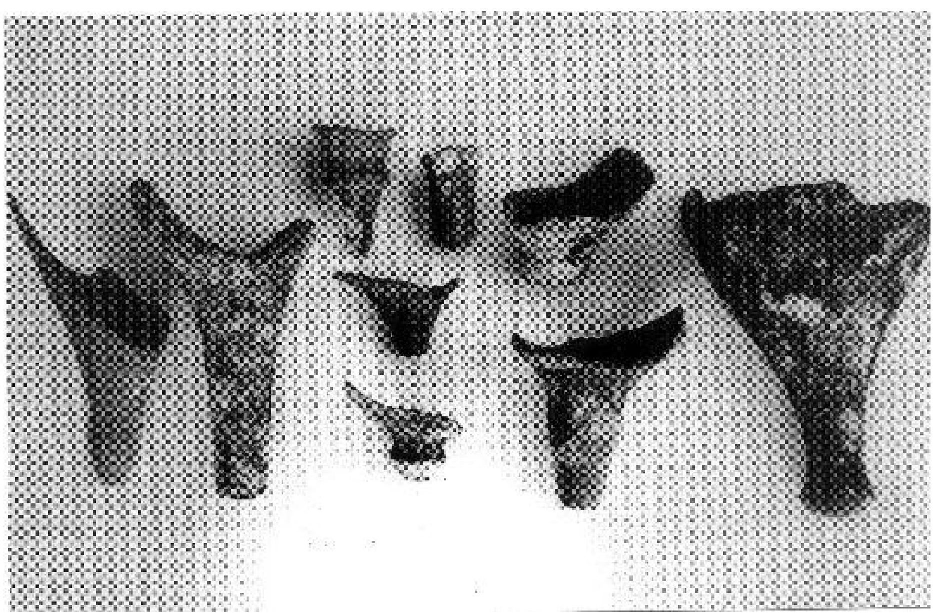


Figure 11 Identifying amphorae by their toes alone is very hazardous. (Marsala 1984, previously unpublished).

Figure 12 Two lamps excavated by Oxford University MARE on the Dattilo wreck in 1987.

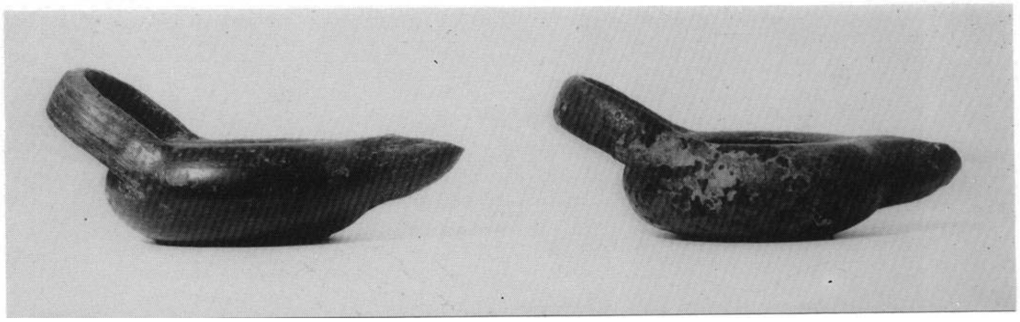


Figure 13 Amphorae made from porous, poor quality clay must be soaked for a period of days in fresh water in order to dilute the salts which it has absorbed, and then dried slowly so that it will not crack. In this photograph, draughtsmen Caroline Caldwell and Francis Rankin pass amphora pieces to Joanna Yellowlees in the "amphora dip" at Marsala. The forms in the water at Joanna's feet are all semi-intact amphorae.

Always make it clear to the team that the draughting instruments are not to be touched. Regardless of this, you can almost depend on it that, every season, somebody will wander into the draughting room and fiddle with the profile gauge until its teeth come out, or block an expensive drawing pen by using it on the cheap paper of a dive log. It is thus wise to make sure you have multiple spares of all key draughting instruments.

As with the team in general, always watch the draughtsmen closely in order to divine their individual talents and strong points, so that they can be employed wisely for the greatest benefit of the project. For instance, certain draughtsmen have a flair for interpretive drawings, others are excellent at texturing, while others are at their best when responding to the challenges that are posed by awkward, problem pieces.

Occasionally there will be troublesome items raised which resist identification, but by working closely with a good draughtsman, you will be able to turn it inside out in your mind's eye, and thus often unravel its secrets. A good draughtsman will worry and tease every last little bit of information from an artefact. Frequently they will see things which others have missed. For instance, the petal stamp on the amphora neck in fig. 12 was detected beneath maritime deposits by an eagle-eyed draughtsman after everybody else had missed it.

Beware of team members who ask to learn to draw. Although their personal enthusiasm and keenness to help is not to be doubted, very few of them will ever be any good within the time limit of their tour with the team, and for most their interest will have evaporated by the second day when the novelty has worn off.

In the meantime a highly trained professional has wasted hours of his time; time in which he could have produced a dozen drawings to the beginner's two or three. Furthermore it is very likely that it will take you longer to correct the beginner's drawings than it would have taken for you to have drawn the pieces yourself in the first place. In terms of productivity it is far better to have all the trained draughtsmen you need when you enter the field, and then to decline politely any well-meaning offers of unskilled help, unless, of course, there is reason to believe that person has untapped talent that will flourish with a little guidance.

Here is not the place for a discussion of the finer points of archaeological draughting; that can all be found in the manuals. Suffice it to say that there are conventions of presentation, technique and scale which should be adhered to where possible, but not slavishly followed, for there will be times when the draughtsmen will have to depart from these conventions.

All drawings must be checked by the director or another qualified person, for it is inevitable that errors will occur; one of the worst sins that an archaeologist can commit, is to bequeath bad information through inattentiveness.

12.3.6. Conservator

It is desirable to have a conservator on the team, but qualified ones are difficult to find. This should not, however, be allowed to discourage you for the range of finds on an underwater excavation are limited and rather predictable, and what you can do with them, within the context of a make-shift field laboratory, is equally limited and predictable. If you study the manuals and consult with those who make conservation their profession, you will find that the application of conservation techniques whilst in the field can be grasped quite easily and quickly, by anyone. There is no great mystery to conservation.

Post-excavation care and conservation is, however, an infinitely more complicated matter and for this you most certainly will need the aid of a professional. As with financing, publication and storage of artifacts, post- excavation conservation is something that must be worked out before a team embarks upon its project.

There is not space here to discuss field treatments and general approaches to such finds as pottery, concretions, metals, etc, but the novice director must be cautioned in the matter of wood, the "tarbaby" of all underwater archaeologists.

A ship's structure is just as important archaeologically as its cargo and other contents, but waterlogged wood, because of its perishable organic nature, presents special problems, which most museums simply cannot afford to accept. They are well aware of the difficulties and never ending expenses that are involved in the conservation of major items of wood. Never - but never - bring up a large piece of ship's structure without careful planning and detailed discussion with the archaeological authorities.

In 1984 Oxford University MARE, while working on the Italian Island of Giglio, made the important discovery of part of a ship's keel from the Archaic period of antiquity. To bring it straight up would have been a conservation disaster, to leave it in situ would have been to put it at high risk from the vandals who invariably dig and plunder the site after the season ends. Reluctantly it was decided that the only course was to bury the keel in the seated, hope that looters would not find it, and return the following season after proper care for it had been arranged.

During the off-season a sample of the wood was analysed, the chemicals were acquired and special holding tanks were prepared. The Italian authorities kindly provided the laboratory facilities. In 1985 we returned to raise the keel, which fortunately was still intact except for a hole in a garboard where the vandals had been digging.

Frequently wood can be studied and drawn while still in the sea, but on those occasions when it has to come up, forethought and planning of the kind described above are essential.

Finally, never be so vain as to think that by giving the museum authorities box loads of amphora pieces that you are doing them a favour. For them this represents more work and the problem of storage; if there is one thing museums the world over have in common, it is a shortage of staff and repository space.

12.3.7 Medical Officer

Always try to include a medical officer on the team. Ideally he or she should be a specialist in underwater medicine. The only problem with a team doctor is that his answer to most complaints, however minor, is to prescribe a day or two off diving. It is a subject of humour on the team, that the moment our doctor arrives we seem to loose half our divers.

I have heard it said that "Badlads bend on Wednesday". Maybe; maybe not; but I have noticed that general illness, if it is to appear, will usually do so on or about the third day. This is something to which team doctors should be alerted, because this is when new members are trying their hardest to fit in, and are thus reluctant to admit they are less than fully healthy for diving.

Make it clear to the medical officer that he is responsible for cleanliness in the kitchen and mess.

12.4 TEAM SELECTION

When it comes to team selection you are in the business of making judgements, and judgements are always subjective and discriminatory. There are no definitive guide-lines that I can give here, for as I have already mentioned there is no such thing as a "perfect team", even though you will probably spend most of your career as a field archaeologist in its pursuit. Nonetheless, most teams are capable of laying the Golden Egg, but it is up to you to coax it out, and in this you can give yourself a head start by devoting care and attention to the matter of team selection.

In multi-season projects team selection and recruitment is a gradual refining process in which you are constantly trying to upgrade the general quality of the staff and personnel. Continuity of personnel from season to season is vital for smooth running, but equally important, is an annual injection of new-blood, for however good the team veterans may be, there is always with them a natural tendency to become, overtime, a little stale. Generally, Oxford University MARE aims at 60 per cent continuity from season to season.

In what follows, I can do no more than give some of the qualities that we look for when putting together the MARE team. I am aware that other directors have other criteria, and that not all will agree with us, finding our standards over exacting and rigorous, but we view team selection as not only the first step towards team excellence, but also the first line of defence against incident, and thus it is an aspect of our programme to which we attach great importance.

With Oxford University MARE we purposely set out to find multi-talented people, that is to say people, who, in addition to being experienced divers, possess one or more technical skills, for on our team we have a growing array of hardware that must be kept running at all costs, and so we need divers who are also mechanics, engineers, electricians, welders, and so on. Furthermore our seasons are long, which means we are never looking for just one, let us say, mechanic, but three or four, so that as one completes his tour, another is arriving to take his place. In a project which, by archaeological standards, is costing a small fortune, we cannot afford to have operations grind to a halt because of breakdown; there must always be on the team an adequate spread of specialist skill and technical know-how, so that we never lose a day's diving through equipment failure. As a director, you will be painfully aware that a non- productive day costs just as much as a productive day, and how, potentially at least, something as trivial as a broken spring can hold the whole project to ransom. The boats, vehicles, compressors, generators, pumps, airlifts, waterdredges, outboards, radios, underwater communication systems, remote operated vehicles, aquascooters, camera gear, underwater TV and video systems, metal detectors, magnetometers, recompression chamber and the excavation computer, must all have personnel who can operate, maintain and repair them.

With the MARE team we aim for a tight working unit representing a synthesis of skills, which, individually and as a collective, can after a few days, work with a minimum of supervision.

It is a much repeated adage of underwater archaeology that you can make archaeologists into divers, but you cannot always make divers into archaeologists. This expression has its origin in the sixties, which is when it may have been true, but with the development of technology, it does not reflect today's realities and certainly not the complexities that Oxford University MARE faces when in the field. This may sound like heresy, but in team selection we are not looking for good archaeologists, for as long as we have one or two competent field archaeologists at staff level, then the success of our season depends to a growing extent on the technicians, most of whom, with a little guidance from team veterans, can also be turned into adequate, if not good excavators. Generally speaking, a good archaeologist is a good archaeologist because he has spent all his adult life in the rather sequestered, and in some ways, unreal environment of academe, concentrating his life on a subject which is remote from the functional realities of modern times. Thus it is not fair to expect him to be skilled or adept with machinery and electronics, etc.

An additional advantage of recruiting technical people and other specialist professionals, is that, more often than not, they are responsible, dependable and emotionally mature. In an operation where the ultimate cost can be human life, these are qualities that you learn to value highly.

In the very early eighties when we were just starting, we relied heavily on undergraduates, but over the years we gradually altered our selection criteria until in our most recent season we had only one undergraduate with us, who was a general assistant, and not a diver.

Generally speaking, we find that undergraduates have few useful technical skills. Many are not ready for the hard work that we demand of our team, and most are not yet emotionally mature, or used to the pressure and responsibility that is fundamental to any serious underwater project where a lapse of concentration or a mistake can, at worst, result in a fatality. The majority of students will probably not see an underwater excavation as a serious scientific project, but rather as an exciting and rather glamorous extension of their summer holidays. In the field they will rarely give one hundred per cent of themselves, and will be as much interested in the beach attractions and night-life as they are in the diving. Somebody who does not usually go to bed until two or three a.ro. is not fit to dive early in the morning, and thus is jeopardising his own safety, that of his diving buddy, and the general welfare of the team. Several people like this will introduce a level of mediocrity to the team which, in underwater work, is unacceptable.

All this may seem rather harsh, but as I look back over the years I am faced with the inescapable fact that the great majority of our serious problems have all been student-related. Nonetheless, if we are contacted by a particularly talented and dedicated student, whom we suspect, may eventually be able to contribute to underwater archaeology in a significant way, we will usually take him or her gladly. Most students we now refer to land excavations where they can learn the trade properly and then return to us later if they are still interested.

A skilled technician will have a totally different attitude, which is far more conducive to the smooth running and successful conclusion of a project. Typically, he will be a family man who has taxes to pay, a mortgage to meet, and only two or three weeks of holiday a year. Usually he has become a little bored with traditional diving and wants to spend his all too short annual holiday involved with something which is both useful and challenging. A person like this will be accustomed to hard work and responsibility, and will instinctively understand the need for discipline.

It is perhaps informative to look at the background of those members of the Oxford University MARE team who were involved in our most recent project, a two week survey expedition which operated from a research boat. The number of berths on the vessel meant that the team had to be restricted to fifteen. Two were archaeologists, two were professional divers, the remainder consisted of a hypobaric doctor, a recompression chamber operator, an R.O.V. operator, a nuclear engineer, a seaman, a boat handler and a mechanic, a draughtsman, an architect, a diving equipment specialist, an aquascooter and underwater telephone and television operator, and a team administrator and treasurer. The average age was thirty-seven. Three of the team were women. The project achieved its goals in a happy and motivated atmosphere, and there were no equipment or personnel problems.

Teams are recruited through advertisement or by personal contact, others write in after having read articles or heard lectures about the work. When advertising you should specify which technical skills you are seeking in addition to diving experience. If you do not do this, you will, in effect, have put out a "cattle call" from which you can expect to receive a very great many inquiries and applications. Replying to them all will take time that you can ill afford, and the expense will also be considerable, since most applicants will not include a self- addressed, stamped envelope. Try to use form letters as much as possible for otherwise you may unwittingly invite a reply. In this kind of activity, the act of keeping down your correspondence (as well as your phone bills) must be developed into an art form.

Hold onto all letters (as well as the carbon copy of your replies) for a considerable period of time, for if your team is large and it has a rather high profile, you can depend on it that you will occasionally attract the odd crank.

The overwhelming majority of the people who write in will have to be sent a brief, but polite, form-letter thanking them for their interest, and regretting that the team is already complete, or giving some other genuine reason why they cannot be considered for membership. Enclosing a photocopy of a recent article may perhaps reduce the disappointment that many will feel, particularly the children.

Send a questionnaire to those that you think might perhaps have the right skills. A copy of our most recent questionnaire is reproduced in Table 1. Those whose interest and enthusiasm is short-lived will not reply, but to those who do, and who are able to present credentials which suggest that they may be an asset to the team, you reply with one or two referees' statements, of which an example is given in Table 2. A bad reference has to be an automatic rejection.

The referee's questionnaire probes the applicant's diving skills, aptitude for hard work, emotional maturity, and several other qualities. A subsidiary purpose of the questionnaire is for the applicant to glean an idea of what we are looking for in him. At this stage he will realise that what he has applied for is not a cheap diving holiday, and a little fun, but a serious project which is going to tax him to the limit.

If the questionnaire is positive, then the candidate is sent the excavation rules, a rather daunting ten page document covering every aspect of team life, and which has a detachable slip at the back which the applicant must sign (to convey agreement) if he is to join.

Although the applicant may originally have written in on whim, by the time he comes to the decision of whether or not to sign, he will have a realistic idea of what to expect, and he will have been to forced to consider very carefully if this kind of commitment is right for him.

At this stage the applicant may well be requested to attend an interview, and if this goes well, he will be required to provide evidence of a recent medical and chest X-ray, as well as a certificate to show that his demand valve has been serviced by a recognised dealer within the last twelve months.

As you (as a novice director) develop in experience, you will find that your instinct starts to play an important role in team selection. Sometimes a person can be qualified, but at the interview, for reasons you cannot put your finger on, you have a gut feeling that he will not streamline with the rest of the team, and so the applicant is reluctantly turned down. I find that to go against my instincts at the interview stage, is, almost invariably, a mistake. The successful applicant will also at this stage be requested to pay the team charges, which, in 1985 was £3.95 a day.

In Britain especially, it is a general principle of expeditions, particularly university expeditions, that members each contribute a certain figure to the cost of the project. The ostensible purpose of this is to assist with the overall costs of the project, but these personal contributions serve a secondary purpose, which is just as important, if not more so, than the first, and that is to ensure that there is a full team on site when work begins. From experience one should be able to calculate almost the exact number of people that the team will need to achieve maximum efficiency and productivity. If on the day, two or three people do not turn up, productivity will be low, and of course, there will be an unreasonable strain imposed on everyone else. Equally, however, if you over recruit, you will rapidly find yourself in the classic economic situation of "diminishing returns". The personal charges are a way of ensuring that the person is serious in intent and that on the day he or she will be there to take up his or her responsibilities. These charges must be paid in advance, and with Oxford University MARE, nobody is accepted on to the team until the money has been received. Once in the field, if someone does not turn up he loses his contribution, for on a tightly numbered team his absence lets every one down and costs the project in terms of productivity, time and money.

It is important to remember when putting together your team that it is better to under recruit slightly than to over recruit. In MARE we try to produce a team that within three days of entering the field is "safe, slick, and seamless". A team that is over-numbered is unwieldy and slow to respond. A team with time on its hands soon develops a taste for lying on the beach, and a knack of disappearing when there is work to be done. Once this kind of lethargy has been allowed to take a grip, it is almost impossible to shake off.

Nor, however, do you want the other extreme, where through force of leadership or whatever reason, the team has become so honed that it can only sustain its level of activity or efficiency by working on its nerves.

So how does one calculate the optimum number for a team? There are many considerations, but one is depth and the type of diving, for a critical factor in your pre-excavation calculations is the gap between dives. Within the usual safety limitations, you naturally want a maximum of bottom time and a minimum of time penalties, but there are only so many hours in the day and only so many dives that can be made either side of the your four or six hour dive interval, and this must be reflected in the number of divers you have on the team.

A secondary consideration is the type of archaeology and type of wreck. A basic guideline on this is how much information your ground staff is capable of processing. Take for example Oxford University MARE'S next project which will be a fifth century B.C. site at Dattilo, off the island of Panarea, Italy, which we know from survey contains large numbers of fine-ware, every piece of which will have to be painstakingly draughted and recorded. If for instance our team was to have twenty divers each doing two dives a day, we know that over a hundred diagnostic pieces could be brought up daily. This would take a very large team on land to digest, a larger ground staff than we could reasonably expect to find or be able to accommodate. On this particular site a team of nine divers, would bring up about as much as we could realistically record, draw and photograph. By contrast, if this was an amphora wreck containing identical amphorae, then the number of divers could be much greater since the task ashore would be easier.

Try to avoid taking habitual complainers or “whingers” on the team. Let people know before they join that in all things archaeology comes first, and personal comfort a distant second. Explain to all new team members that under no circumstances can they bring with them, or invite, girl/boy friends or other acquaintances. “Hangers-on” however well meaning and pleasantly disposed, usually, by their very presence, disrupt work schedules and distract ground staff.

It should also be explained in advance that the chief-divers and staff are under no obligation whatsoever to "get divers in the water". Divers are first and foremost members of an archaeological team, and not a diving expedition organised for the sake of diving. It is taken for granted that applicants are attracted by the intellectual and other challenges of underwater archaeology.

Usually if an applicant is happy with the work he will want to continue with the team the following season, and will be pleased to work and assist during the off- season with the myriad of tasks that must be attended to, such as maintenance and repair. We have found that in a big team, it is frequently best during the off-season to break the team down into cells which are defined according to location. Thus a cell in London will handle boat maintenance, a cell in Oxford will operate as research assistants, and so on.

12.5 ALCOHOL, DRUGS AND SMOKING

Alcohol consumption is one of the perennial problems of underwater archaeology. However you look at it, alcohol is "a sedative and narcotic drug which will potentiate nitrogen narcosis, bringing it on at much shallower depths than would be anticipated..... It is not generally realised that alcohol takes some 36 hours to be eliminated from the body. Alcohol can only be metabolised by the liver which thus becomes a bottle neck as it destroys only a limited amount of alcohol each hour." (Dr J Betts, Diver Nov. 1984).

With these truths in mind a director's course should be fairly obvious, that is to say, rule on the side of safety and ban all alcohol consumption. But it is not as simple as that. For us, no other issue has been more divisive over the years than that of alcohol consumption. Some are adamant, ferocious even, in their view that there should be no alcohol consumption at all and refuse to dive with anyone they see drinking; others are equally adamant that they should drink as much as they are used to drinking at home. Others advocate modest drinking. Some feel that what they drink is their affair, but on a diving project which is based upon the "buddy" system, this last view is plainly a nonsense. In short, this is an emotive subject on which most people will have strong feelings, ensuring that whatever the director decides will not be well received by all.

On our team we have tried banning alcohol altogether; most accepted this ruling, but it did not stop the determined drinkers and only made them more secretive. We have tried removing the ban completely, but this was the worst decision of all. For a short time we tried restricting drinking to days off, but this soon failed as one or two people over-consumed regularly so that it was not safe for them to dive the following day. On a project where every second of bottom-time is precious, it is the height of irresponsibility to be off diving because of something as avoidable as a hang-over. We have also tried allowing one glass of wine with the evening meal; but one glass soon became two glasses, and we found that those who were accustomed to going off to a bar in the evening were still doing so.

In 1984 we contacted three leading medical-diving specialists to seek their views. They were, unanimous in their opinion that diving and alcohol do not mix. One pointed to the North Sea professional organisations, where, if a diver is caught drinking, he is on the next helicopter to the mainland.

In a team that is selected as much for its emotional maturity as for its technical skills, the vast majority are perfectly responsible with alcohol, but on any large team you will have your sinners as well as your saints and it is always just the one or two who manage to spoil it for all the rest.

As with most personnel problems, it is better to try to catch them at the vetting stage. Generally speaking, we have found over the years that it is the undergraduates who, through immaturity, have caused us most concern over alcohol abuse, which is one reason why we tend to have few students in the team (see section on team selection). At interviews it is, as a rule, remarkably easy to probe a person's attitude to drink, particularly with the late teens and early twenties who are sometimes impressionable enough to think it clever, or somehow a mark of manhood, to drink heavily. It will be noted that the matter of alcohol also features on our referees' questionnaires.

Whatever the answers - and there are none really -it is an inescapable fact, that, over the years, with one exception, all the scares we have had underwater, as well as one or two of our major problems on land, have been drink-related. For instance I recall the case of a person who became dizzy after entering the water, later admitting that he had drunk a bottle of beer just before the dive. Another diver who became nauseous and panicked at 20m., admitted later that he had been drinking heavily the night before. And then there was an occasion in Sicily when a member of the team became aggressively drunk and beat up the son of our landlord.

At present our excavation rules allow for a moderate amount of drinking on the evening before a day off diving. With the help and watchful eye of chief divers and other responsible members of the team, this seems to be working.

It is to be lamented that there are people who are prepared to abuse their body chemistry through regular use of drugs, but these people do exist, and from time to time, especially if you have a large team, a drug user will slip through the vetting procedures. The possible lethal consequences of this on a diving project do not need to be explained.

Although the drugs problem is not something that will occur often, it is one that a director working aboard can not afford to forget or dismiss, for, quite apart from the safety aspects, it can have a damning effect in terms of public relations and goodwill, and will drag the reputation of the team, and that of its university, or other associated bodies, into disrepute. Laws abroad can be severe on drug-users, and any litigation will inevitably involve the team administration, even though it had no knowledge of the individual's habit.

In over half a decade of work, and several hundred team members, there have been only two recognisable cases of drug abuse, both with students.

Since the health of the team is a major concern (Table 3), applications from smokers tend not to be accepted. The dismerits of mixing smoking with diving need not be laboured here beyond the following terse observations which I take from the Professional Diver's Handbook (ed. D Sisman, Submex, 1982, p.242):

Cigarette smoking reduces fitness. It also has the following effects:
- it reduces breath-holding endurance
- it reduces risk of burst lung
- it reduces heart efficiency
- it causes lung disease
- it causes heart disease

12.6 Discipline and Morale

Discipline id fundamental to the working of a good team, for without it there cannot be safe diving or high quality archaeology. In the first instance, as with most aspects of team behaviour and management, discipline depends on the director, but the implementation and observance of disciplined activity depends on the staff, and , in particular, the chief divers.

A good director must always be on the lookout for the first symptoms of collapsing discipline. The signs to look for include slowness to rise and mobilise in the morning; boats running well behind time, a general aimlessness towards schedules and rotas, a poor attitude to competing dive log, a disregard for other people's diving gear, etc.

The height of unprofessional behaviour in an underwater archaeological expedition is rowdy behaviour in the boats, such as pushing people in the water for a laugh. This kind of conduct usually escalates, for it is never just one person being pushed, but two or three, and before you know it excavation cameras, or worse, actual artifacts are being broken.

Here is not the place to comment on correct behaviour underwater as that is basic diving training, but it is important to instruct every diver to respond immediately to signals from the surface (for exciting discovery may tempt some to ignore them), to observe a basic reserve of air in bottles so that he never come up empty, and never to waste time chasing fish or lobster.

The person who wastes time underwater is like a canker on the team and must be dismissed for, such loose attitudes can easily become infectious. Because of the expense, and the consequence pressing need to justify it through archaeological achievement, every second of bottom-time is precious. For this reason it must be made clear in the expedition rules that spearguns are not permitted, and that people are not allowed to collect, for example coral or sponges. Permission must also be obtained before persona cameras can be taken underwater.

Poor discipline in the potshed is also to be avoided at all costs. Symptoms of this are dirty instruments, stagnant water in the baths, general messiness and, of course, being behind with duties. Just as the state of diving discipline is a measure of excellence of the chief-diver, so is the state of the potshed a measure of excellence of the recorder or conservator. It many countries you will receive visits from the archaeological inspector who is there to make sure that standards are observed.

Indiscipline in the kitchen and mess areas spells poor hygiene. A stomach bug can decimate a team in a couple of days; cleanliness will help prevent such outbreaks, or, should they occur, then help contain them.

Morale, of course, is important for the smooth running and general well-being of the team, but here there are no formulae that will guarantee success. Good food, and lots of it, will help, for it is generally recognised that expeditions, like armies, march on their stomachs.

Bad weather and equipment problems, or anything that prevents diving can be demoralising, for there is something in the thought that a tired diver is a happy diver. Maintaining a high level of interest in the work is important, and in this I have found that lunchtime lectures, after the debrief, on some aspect of archaeology related to what the team is doing, will usually help.

On Oxford University MARE expeditions, we have over the years evolved by accident a tradition of celebrating acts of minor stupidity that have no effect on efficiency or productivity, with what we call Pink Panther Awards. These awards - which actually feature a three foot high stuffed version of the cartoon character - are never given in malice, always in a spirit of fun. Anybody can make a nomination, and, in nominating somebody, exaggeration is allowed, even expected. If there is more than one nomination, and there frequently is, then the recipient is decided either by acclaim, or by a show of hands.

The Pink Panther Awards are always made following the evening debrief. After a long and intense session, which sometimes has had to include a few hard words and unpopular decisions, the Pink Panther Award ensures that any hard feelings are left in the briefing room and that everybody breaks up with a smile. A light- relief of similar device, I would recommend to any team.

12.7 MONEY MANAGEMENT AND INSURANCE

Underwater archaeology is far more expensive than terrestrial archaeology, and much of a director's time during the off-season will be spent fund-raising. Here I have no tips to give except to stress the importance of a good prospectus which does not try to dazzle with big words or science. That is not to say that you should reduce everything to "Readers' Digest" level, but rather, that you must keep the prose honest, plain, and free of contrivance, and where you must resort to complicated concepts, then explain them. A map is always a good idea, and a realistic budget is essential. It is always wise to add a 10% contingency figure to the final sum of your budget.

A large part of your budget should be devoted to post-excavation publication costs. From colleagues who are involved with major land excavations I understand that, as a rule-of-thumb, publication costs (such as inking, copy- proofing, photographies, etc.,) are now totalling over fifty per cent of the budget. In underwater archaeology our publication costs are not as high proportionally, because of the way our budgets are inflated by equipment overheads; but nonetheless, publication costs are still an overriding factor, and thirty five to forty per cent of budget would perhaps be a realistic projection for a major underwater excavation. For survey and smallish single season projects, it would be less.

It is likely that in everything you do you will have three budgets in your head: first, an ideal one which gives you all the equipment you would like to have and the option of simply buying your way out of the inevitable problems you will encounter while in the field; second, a lean and practical budget which should, realistically, allow you to achieve your objectives; third, an absolute minimum budget with which you could still enter the field, but at the cost of cutting equipment, team and time, and possibly compromising the chances of obtaining your goals.

If you are affiliated with a university then the university itself will probably be your best source of support. Some of the smaller learned societies may consider an appeal sympathetically, but it is unlikely that the major learned societies which have traditional links with archaeology will regard your prospectus with favour the first year, and will only be persuaded to help the second year if you can prove from your first year's work that the site is of significant archaeological value.

Remember that the majority of the learned societies do not have large sums to give and it is the duty of their trustees and committees to ensure that what they do have is distributed fairly. Obviously you do not get if you do not ask, but with learned societies, the very act of asking will cost you a minimum of two days work filling in their forms and arranging referees. This is time you can ill afford, so it is usually wise to write briefly in advance to see whether the project is likely to be eligible.

Most firms and businesses are more likely to listen to appeals for gifts in kind than for money, but however successful you are with your gifts in kind, on the day it is hard cash that you will need, and as your fund-raising year melts away, this is something you forget at your peril.

During the year and in the field you will need a treasurer to handle your book- keeping and accounts. In the field with a big team this will be an almost full time job in itself.

A treasurer will need to have some instruction in the fundamentals of book- keeping for he or she will have to maintain up to date written accounts at all times, impose tight fiscal control on the team, and be able to give the director financial forecasts on demand. Above all the treasurer must be almost pathologically honest.

If your team becomes big in size, assets and objectives, then the money you will be seeking will also become big, and if this happens you must be as professional with the finances as you are with the archaeology. When you are seeking big money, the first item that a potential sponsor will ask for is a copy of your last audit, for in this kind of fund-raising, financial credibility and integrity is just as important as archaeological credibility and integrity.

For tight money control, and just as importantly, for the psychology of tight money control, every single transaction, however humble, must be receipted . With Oxford University MARE every purchase, or group of purchases, made by a member of the team is shown on a prepared page (Table 4) and then the page is numbered so as to cross refer with the ledgers, which chronicles the overall daily money flow. The loose-leaf folder containing the treasurer's sheets, go with the ledgers to the auditor at the end of the season.

The blight of underwater archaeology is insurance. I have found no solutions on how best to insure equipment, etc. All teams members must have individual insurance for illness, hospitalisation and repatriation. Additional insurance is recommended for personal equipment. In large teams, it is inevitable that every summer somebody will require medical attention, and occasionally hospitalisation. For that reason every member of the team who is from an EEC country is obliged to obtain an Fill form from their local DHSS office which should guarantee them, at little or no extra cost, medical attention similar to that which they would receive on the National Health in Britain.

12.8 LITERARY RELEASE

It is a sad fact that there are writers who will exploit without scruple the work of others for the profit of their own pocket. Such people will not generally make their intentions plain if they come into contact with the project. The only protection is to have everybody associated with the expedition sign literary releases, staling that they will not, without first obtaining written permission, write about the project or its findings, or pass on information to authors, journalists, members of news disseminating organisations, etc.

Quite apart from the ethical considerations, such piracy will represent lost income and, most important of all, threaten your permits and possibly pass on bad archaeological information.

If you are working abroad, you will have to sign legally-binding permits. It is likely that one of the conditions contained in the deed of concession will specify how you publish, and it is equally likely that, quite properly, you will find yourself obliged to publish first in a scientific journal of the host country before you can publish at home.

Someone else publishing outside the host country puts you in violation of your signed agreements. That the project has no control over the pirated work, and most certainly did not consent to it, is irrelevant. By this time you are fighting to save the project, for without the annual renewal of the permits, the work cannot continue.

Finally there is the nature of the pirate publication itself. More than likely the writer will not be qualified to comment archaeologically, and what will result will be archaeological nonsense. Since serious scientific publication of a project's work will take several years, other writers will have little choice but to look at the unauthorised and inaccurate publication, and in this way, its misinformation will be perpetuated in the writings of others. The disservice to archaeology and historical learning can be considerable.

12.9 APPRAISAL OF A NEW SITE

Archaeology is not like mountain climbing: one does not excavate a site because it is there; nor, like Columbus, does one set out not knowing in advance what one will find. Survey (by which we usually mean no more than careful reconnaissance) is therefore a vital part of any underwater archaeological programme.

When assessing or surveying a new site, I find that I always have three questions, or factors, in mind: risk, costs and archaeological information value. It is an equation that never balances, for how can you ever quantify or measure archaeological value, or costs against risk, but these, nonetheless, are factors that you find you are constantly having to weigh.

In underwater activity of any kind the element of risk is always there. The records show that depth is not always the critical factor in underwater incidents, but nevertheless, the question arises as to how far and how deep you go in the pursuit of historical truths. With an uneven team, on a heavily looted wreck of, for instance, 1st or 2nd century AD date, of which many have been examined already, one would perhaps not want to go much beyond 30m; but with a well- tuned and highly experienced team, in benign diving conditions, on a wreck of, for example, Mycenaean origin, one would be prepared to go deeper. But of course it does not matter how expert the team or how carefully you vet and select, there are always the "objective* dangers over which the diver, however skilled, has little or no control.

The cost factor is much easier to assess, but any way you look at it, proper underwater archaeology is a very expensive undertaking especially when compared with archaeological work on land. When you divide up your annual expenditure by the number of people on the team and number of days in the field, the daily per capita costs can be somewhat alarming, which is why directors can be so sensitive about loss of dive time when brought about by a member's individual idiocy (e.g. sunburn; a forgotten item of dive equipment, etc.) or just general inefficiency.

Because of the high cost, productivity must always be high, and the whole project must be able to justify itself in terms of the value of its archaeological information.

Your estimate of the site's information value, is, of course, a function of erudition and experience. If a director cannot make the assessment with some accuracy, then it is to be doubted that he or she is ready for the responsibility of directing.

These, then, are some of the issues that will effect your judgement when considering a new site. If, after having deliberated upon the three factors, you decide that the site is worth a thorough survey and possible excavation, then you must next begin the complicated task of acquiring permits from the appropriate government ministry, or other organisation entrusted with the regulation of overseas archaeological teams. The matter of permits varies from country to country, but if that country has a "British School", then your wisest step would be to begin by seeking the advice of the director. With some countries (such as Greece at present) it is almost impossible to obtain permits for wreck work, while others (such as Cyprus) are remarkably lenient in their scrutiny of a new team's qualifications: the majority, however, will only consider giving a permit after close examination of the project's finances, and the director's academic credentials, field experience and technical acumen.

Remember, the days when you could help yourself to another country's antiquities are, thankfully, over, and in most countries to take even a simple body sherd from an archaeological site, without prior authorisation, is illegal. Do not therefore enter the field unless you have the correct documentation to show that your project is fully authorised.

12.10 A TYPICAL OXFORD UNIVERSITY MARE DIVE

A typical dive day begins with a briefing after breakfast. Usually the Director and Chief Diver meet before the briefing to go over schedules and the general plan for the day. At the briefing each pair of divers is given their terms of reference for the morning; this will include not only their dive plan but also their time-keeping, boat handling and standby diver duties.

The first boat of the morning will be the time-keeper's boat which will leave for the site before 8 a.m. In this boat will be the time-keeper and the standby diver. It is their duty to tie on to the buoyed shot-line, to clip an emergency bottle of air to the line and then let it sink to the bottom on a rope. Once this is done, a second set of emergency air bottles is clipped onto the shot line at 5 and 10 metres in case somebody should run out of air while decompressing. The contents of each emergency air bottle are checked every day and their demand valves tested.

The time-keeper's boat will remain on station all day, and, as new shuttles arrive, they tie on to the time-keeper's boat.

The only people on the time-keeper's boat are the time-keeper, the standby diver, and sometimes the director and chief-diver. Communication between the time-keeper's boat and the shuttles is kept to a minimum to avoid distracting the time-keeper. For safety reasons all finds, cameras, tools, radios, aquascope, etc. are kept in the time-keeper's boat. When finds are brought up they are passed, still in their bags, into the time-keeper's boat. Finds are not passed around or examined; they go straight back to the potshed, where, in conjunction with the recorder or conservator, they can be examined when the diver is writing his log.

The first shuttle of the day will arrive on station soon after the time-keeper's boat. It will contain the first and second pair of divers, the first of which will have kitted up ashore and be ready to enter the water immediately.

A record is kept of everybody's air consumption. This is to stop arguments that may later arise regarding air, and also to help staff spot deep breathers who may need to have their dive plans tailored so as to accord with their air needs. Before entering the water, the divers give the time-keeper the cubic capacity of their bottle and its contents. The depth, bottom time and decompression stops are given before entering the water, but once in the water they are usually double- checked with the time-keeper.

The time-keeper is also the dispatcher. When he is content that everything is in order and that the standby diver is ready to dive if needed, the first pair will be allowed to roll backwards into the water. In the water they will be passed their drawing boards, finds bag, tools, etc. They then proceed to the shot line.

When the divers in the water are ready, they raise their arms and give "O.K.." signals, which they hold until they are dispatched. When the time-keeper sees two "O.K.." signals, he raises his arm high with his fingers also framed in an "O.K." signal. This shows that he has received their signals and interpreted them correctly. All signals must be clear and definitive, and the time-keeper must try to avoid positioning himself between the divers and the sun, which makes it difficult for divers to read signals.

When there are three arms in the air all displaying "O.K.." signals (i.e. the time- keeper and two divers), the time-keeper will begin a count down: "20 seconds to dive....10 seconds....5 4 3 2 1, begin dive". Everything in our system of diving is taken to the second, not because a second makes much difference, but because it imposes a discipline of mind on the team, and prevents time-keeping from deteriorating. Once time-keeping begins to become indifferent, it will soon grow worse and it will not be long before the casual attitudes and inattention to detail that allowed this to happen spreads to the divers and other aspects of team work. Bad habits, once entrenched in a team, are very difficult to eradicate.

At the end of the time-keeper's count down, the divers fix the bezels on their watches, or set their digitals, and then begin their descents. The divers proceed to their place of work and begin their tasks immediately. Since bottom time is always at a premium, people are not allowed to spear fish, chase lobster, take holiday photographs, etc. A whole year's effort will have gone into mounting any underwater expedition and very likely will have been paid for, in good faith, by one or more sponsors, who certainly would not wish to find that their confidence has been misplaced and their money wasted. Thus it is the ultimate irresponsibility for a diver to flit away his bottom time, because he is bored, or because he is more interested in the marine life than the archaeology. Such people make a nonsense of everything that everybody else, at home and in the field, has worked so hard to achieve; when such people are identified they have to be dismissed from the team.

Diving, as always, is done on instrumentation. That is to say, each diver watches his contents gauge, depth-meter and timer, but in case a diver becomes slightly narked, or forgetful because of the excitement of discovery, and fails to monitor his instruments, there is a system of signals from the surface to remind the diver of time. The first signal is called the "2 minute warning". It consists of a series of double hammer blows on a hollow metal container which continue for exactly 30 seconds. The divers then know that they have exactly two minutes to complete whatever they are doing: take a last measurement, tie off a piece of rope, stop the air-lift, etc.

When divers first hear the signals they turn to each other and exchange clear "O.K." signals. The purpose of this is to show that they have heard the signal, interpreted it correctly and that they are not narked, or, what we in MARE call sometimes, being "off in punchy-land" (a boxing term for fighters who have been left a little simple-minded and punch drunk from being hit too many times in the head).

While the first pair is down, the second pair of divers will have been kitting up. On the 2 minute warning, they will enter the water, and then, all being well, they will be dispatched at the final warning in the manner described above.

The final warning consists of a continuous series of blows on the sound device. The divers must then cease immediately whatever they are doing and begin their ascents up the shotline to the surface.

If the dive has been shallow it is likely that the divers will have had what we call "snorkel cover", that is to say, a diver hovering over them on the surface. If the dive was beyond visual range, then, by the time the divers begin their ascents, the standby diver will be watching for them with an aquascope.

As soon as the divers come into view the person with the aquascope shouts: first diver in view.... second diver in view".

If it is a decompression dive, then for the benefit of the time-keeper, the person with the aquascope shouts: "first diver at 10 metre stop... second diver at 10 metre stop. The time will be noted. As soon as the divers reach the first decompression stop, they exchange OK. signals, and then lean back and extend their arms, so that they are parallel with the surface, and give OK signals to the person with the aquascope.
The person with the aquascope returns the signal by putting his hand in front of the glass, where it will be visible from below.

The second pair of divers (who begin their dive on the final warning), will by this time, have passed the ascending pair. As they pass OK signals are exchanged. Sometimes it is necessary for the second pair to await the return of the first pair to the surface in order to discuss what is to be done during the coming dive.

While divers are decompressing they can, if they wish, exchange notes with the surface on a writing board which is suspended from the time-keeper's boat on a cord. During Oxford University MARE'S seasons on the island of Montecristo, frequent use was made of an underwater "telephone" system to converse with the divers as they decompressed, and sometimes as they worked on the seabed. Signals are exchanged with the boat as the divers move up the shotline to the next decompression stop. Again, time is noted.

On the surface divers give their air contents, and this, together with their time of arrival at the surface, is noted in the time-keeper's book.

The divers pass their finds, still in the bags and plastic boxes, into the time- keeper's boat, and then are assisted into the shuttle, which as soon as is practical, will return to shore.

Routine status reports are transmitted by the time-keeper or standby diver, to the headquarters radio which is always "on" in either the potshed, excavation office or draughting room. When a shuttle leaves the site, headquarters is alerted that a boat is on its way in to disembark finds and divers. This keeps headquarters in touch with progress on site, and enables them to have new divers ready on the quayside with a minimum of delay. If the finds require immediate attention, or special containers, then this also can be waiting on quayside for the returning shuttle. It must be impressed on the team that the radio is an important excavation tool and safety aide, and must never be used for idle talk or joking.

Table 5 is a typical example taken from the time-keeper's book which details a dive similar to the one described above. Only the names have been changed. This is the manner in which all Oxford University MARE dives are logged by the time-keeper.

12.11 LOGGING AND DOCUMENTING OF FINDS

In an operation in which many thousands of artifacts may be raised in a season, it is vital that there is always tight control with the finds from the moment they leave the seabed until the time they are given into the care of the archaeological authorities. In our system the first "control" begins with the time-keeper's book. Every dive is numbered consecutively and this is entered in the first column of the time keeper's book.

When the diver returns to base he fills in his dive-log immediately while the dive is still fresh in his mind. In the top right hand corner of the page the diver writes his dive number, and then after the form has been completed, he clips it into a loose leaf binder following the page of the diver whose number precedes his own.

The diver's log is the second "control". When the recorder is faced with a rush of artifacts, it may be a considerable time before every piece is fully measured, described and inventoried. Without some kind of immediate preliminary recording of the artefact, things can, even in the best pot-sheds, become confused. A diver without training cannot be expected to give a good archaeological appraisal of what he has raised, but he can give a description and do a sketch or tracing, which afterwards can be very useful to the recorder, who is able to identify and discuss the salient archaeological features at a professional level.

The diver's log is not just a control device for artifacts. It has a secondary function as a control device for divers. It is inevitable that on any team there will be a few people who are slow, or if given the chance, altogether remiss in filling in their log pages. With this system, however, any diver who has been derelict in this duty can be identified by the recorder of conservator by simply noting which page numbers are absent from the log. To put a name to the missing numbers it is a simple matter of referring back to the time-keeper's book where the numbers appear with the names. People who have not filled in their logs are then named at the debriefs. In this way all logs are completed and there is no risk of unlogged, and therefore perhaps untraceable, artifacts appearing in the potshed.
The Table 6 is an Oxford University MARE log page. The headings are self explanatory.

Once the artefact has been logged by the diver, it is left soaking in fresh water in the potshed to be recorded and to receive whatever treatment it may require from the conservator.
The recorder is a non-diver who ideally should be an archaeologist with experience at potshed operation. It is his, or her job to see that every find is fully described, measured and inventoried. Table 7 is an Oxford University MARE artefact sheet. These pages constitute the third "control". There is one page for every item raised, even if it is no more than a featureless fragment. These forms contain the bedrock information that is used to compile the reports and prepare the scientific publications. Once an artefact has featured in a definitive manner on one of these pages, the diver's log, on which its existence was first noted, becomes largely redundant.

The form begins by naming the site and then noting the artifact's substance (pottery, wood, metal, etc.). The find is then given its inventory number, the final part of which is also used as the page number for easy reference. The excavator's name is reproduced from the diver's log, and the form is then cross-referenced with the excavator's log page number. The central sections of the form needs little explanation except to say that the sketch, when a tracing is not possible, has to be fairly precise.

While the artefact is being recorded, the conservator will begin a further form, which, over time will describe the history of the object's conservation. Since at the end of the season it is likely that the finds will pass to the care of another conservator, it is vital that the new conservator is informed fully of what previous chemical attention the artefact has received. Table 8 illustrates one of the conservator's forms that is used by Oxford University MARE. Once the object has been attended by the recorder and conservator it is then passed to the team's draughting corps or photographer. If the object is particularly delicate it will always go to the photographer first in case there is an accident in the course of draughting. The number of the film in which the object appears is written on the recorder's artefact page by the photographer. When the item has been drawn, the draftsman will record his name on the same page, for every drawing has to be checked, and any errors referred back to the original draughtsman for correction.

12.12 EQUIPMENT

On the matter of scuba equipment I have no new advice or insights to offer, except to deplore the common practice on some teams of floating amphorae to the surface by turning them upside down and dumping air into them from your demand valve rather as you would a lifting bag. Not only is this bad archaeological technique (for you lose any clues as to the original contents of the jar), but it is also dangerous because displaced mud can fall back into your demand valve so that, when you breath in, you are given a choking combination of water and debris. "Vegetable soup" as one amphora collector who experienced it at 42 meters, described it to me.

Beware of gimmicks of any kind, for they can waste large sums of money and days of time; particularly be wary of gimmick-minded people or compulsive tinkerers. Generally speaking, if the machine works do not let them fix it. Equipment maintenance to the manufacturer's recommendations, however, is vital to the success of the project, and in this you should appoint one qualified person to be in charge. He will need one or more assistants.

Never plan a season in such a way that its success pivots on one or two key items of equipment (such as a single compressor), for they will be as a gun at your temple; if they break down the whole project is interrupted. If you do not have the spare part, acquiring it while abroad can be the task of days, even weeks.

The following comments on equipment, of which we have had some experience, may be of use.

RECOMPRESSION CHAMBER (Fig. 7b): For obvious reasons it is a very useful item to have. Strange to say, acquiring one is not that difficult, it is later that your problems begin. To start with, insurance is at your throat again. On this you should seek professional advice, for the possible legal eventualities of operating a chamber are cause for concern. If you decide to take one you should include on the team, a qualified chamber operator and a doctor, who should also be covered by insurance in case a treatment goes wrong or does not work.

Consider in advance the moral and legal quandaries in which you might conceivably find yourself. What, for instance would you do if you are in an isolated spot and a sponge or coral diver turns up with a "bend". Think how this might affect your insurance. Would you treat him, or would you try to transport him to the nearest underwater medical centre. What would be your moral and legal obligations?

Suppose the diver turns up the day after the season ended and neither the doctor nor chamber operator are any longer with the team? (This once happened to two colleagues and myself. We decided to treat, and thankfully it worked). On the other hand, what if you do not take a chamber and one of your divers has a "hit"? Can you have him transported to a medical centre that has a chamber in reasonable time? These are some of the questions and solutions you must rehearse in your mind

And then there are the practical considerations. Can you afford a truck to transport the chamber? (Fig. 15) In the field a chamber can be awkward to plumb. Small replacement parts can be difficult to find abroad. How would you keep it cool if you are in a hot, exposed area? What about obtaining oxygen? Since the chamber will probably weight several tons you will have to find a crane to lift it. A chamber is also an enormous item of impedimenta, and although this would not be a problem for some teams, on ours, where we value our mobility, we find that a chamber can hamper our movements badly.

AIRLIFTS: With large overburdens of sand, airlifts are essential. The main problem is finding a stable platform over or near the site, on which to seat the airlift compressor.

On delicate sites we have used WATERDREDGES which can be more gentle. Their advantage is that they can be driven by a small, petrol-fuelled pump, capable of being carried on a pallet inside an inflatable. It is essential that the hosing which delivers the water down to the seabed is in good condition, or you will spend more time repairing holes, than you do operating the dredge.

UNDERWATER TELEVISION by itself we have not found to be of great service but, in conjunction with an underwater communication system, it can be of use.

UNDERWATER TELEPHONE LINES from the time-keeper to the divers can be a useful safety back-up when the divers are working in one place, but again we have not found, in practice, that they aided the work greatly. An underwater telephone line to the decompression stops is, however, useful as a safety device and as a means for briefing the next pair. (Fig. 16)

SHIP TO SHORE RADIO: A radio link between the boats and headquarters ashore is essential for a well-oiled operation. In the event of an accident such a system allows you to alert the emergency services quickly.

METAL-DETECTORS: We have used them with great success in searching for sites that are concealed beneath the sand. We have also found them to be particularly useful for exploring and establishing the periphery of a site.

In the last two or three years, with the advent of small, cheap models, they have become part of the equipment of the clandestini and, although it is not good archaeology, we have been forced to use them to isolate and extract the metal small-finds from sites in the certain knowledge that, if we did not do it, the vandals would after we had left.

MAGNETOMETERS: The value of magnetometers on wrecks from antiquity is perhaps limited by the sometimes minimal metal content of ancient ships. We have had no success with our magnetometer. Maybe we have been unlucky. On those wrecks of later date, which carry cannon for instance, I have seen the magnetometer used with excellent results.

ECHO-SOUNDER: We have found high quality, sophisticated echo-sounders to be useful during bottom searches, and for position fixing.

AQUASCOOTERS AND AQUAZEPS: These are of great service in search-and- survey work as they allow you to cover vast areas of seabed in a minimum of time. Furthermore, the inactivity of the diver reduces air consumption dramatically. (Fig. 17)

REMOTE OPERATED VEHICLES: Thirty or forty years ago we had man's entire history as a seafarer spread out within easy depths on our ocean floors; but now, because of vandalism and the mania for amphora collecting, most of these wrecks have been destroyed. One of the last great frontiers of archaeology is the study and excavation of wrecks that lie beyond standard diving depth. The problem, however, is to penetrate these depths safely and to find the wrecks. (Fig. 18)

In recent projects Oxford University MARE has been using a Remote Operated Vehicle (ROV) fitted with position-fixing devices, echo-sounder, camera and video equipment. The ROV is controlled and its progress watched by the use of monitors on the mother ship. With this we have been exploring depths between 50 and 130m with some success.

BOATS: Generally speaking MARE prefers to be based on shore and to work from a fleet of inflatables, but in recent seasons we have also made much use of large charter boats which we fit out as research vessels (Figs. 19 & 20). These permit us to reach remote and inaccessible areas, but there can be no doubt that the processing of the finds and quality of the paperwork and archaeology in general suffers. They do, however, offer a stable working platform from which to run the air-lift compressor, house the recompression chamber and operate the ROV. The expense of such vessels is considerable and, to justify it you need to obtain what we call "Grade A" archaeological information. Sometimes the same result can be obtained for less expense by using a barge or pontoon anchored at four corners over the site.

Remember that in many countries, Italy, for instance, boats (including inflatables) and outboards above a certain horse power, have to be licensed. There are also rules which are stringently enforced, about the safety equipment that boats must contain. Information about this can usually be obtained from the main tourist office of the country under consideration.

.....And finally (the bugbear of all underwater archaeologists),
Try to be patient with other archaeologists from whom you will hear from time to time something like this: "Ah yes, all this diving business is very fine and jolly, but don't you think it's about time you did a little proper archaeology?"

Acknowledgements: I am grateful to Mr John Yellowlees who read this paper and made many helpful comments and suggestions, and to Poolo Scremin of the Institute of Archaeology at Oxford who gave valuable assistance in helping to prepare at short notice many of the above illustrations.
(Figure Captions)

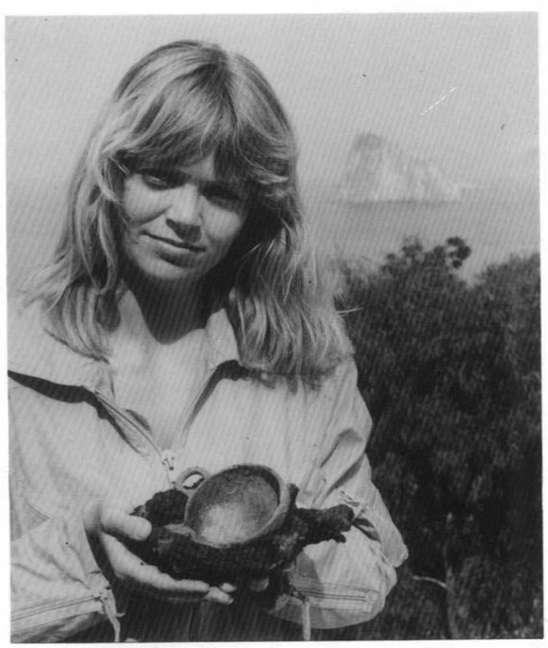


Figure 14 Every site presents it's excavator with a different set of problems. Work on the Dattilo site was complicated by large areas of concretion. In this picture, Joanna Yellowlees displays an intact drinking patera which she found enveloped by concretion and which had to be cut free with a hammer and chisel. Concretion is still adhering to the cup in her hand.

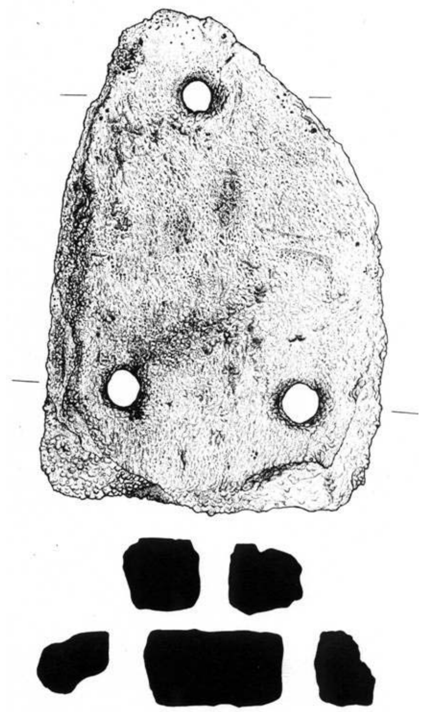


Figure 15 Drawing of stone anchor in figure 9a. Note the use of sectioning and texturing.

Figure 16 Time-keeper, Georges Parmentier watches the divers as they work and converses with them on a telephone system.

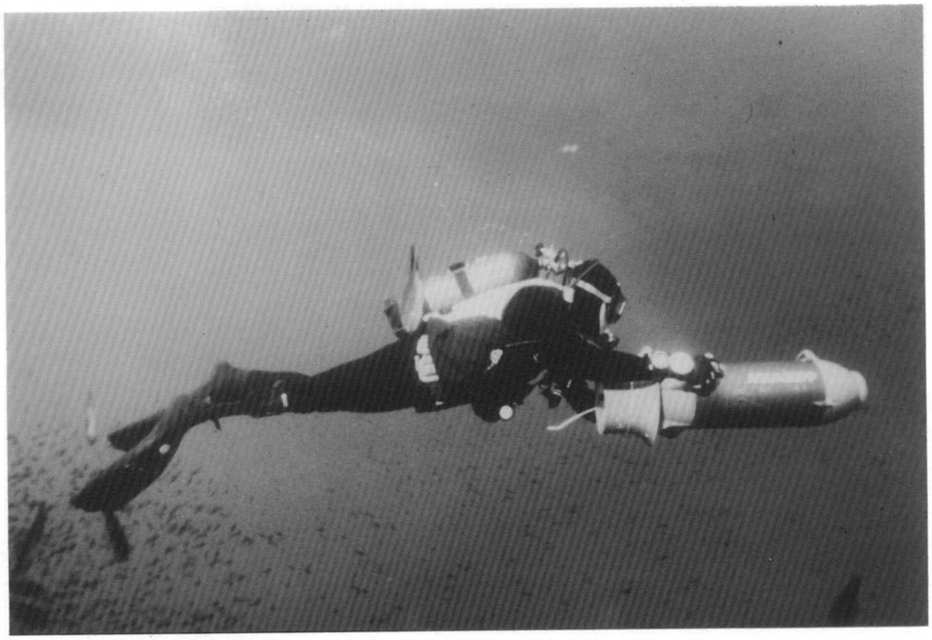


Figure 17 Recently Oxford has made much use of aquazeps in seabed searches (photograph Gian Luigi Sacco).

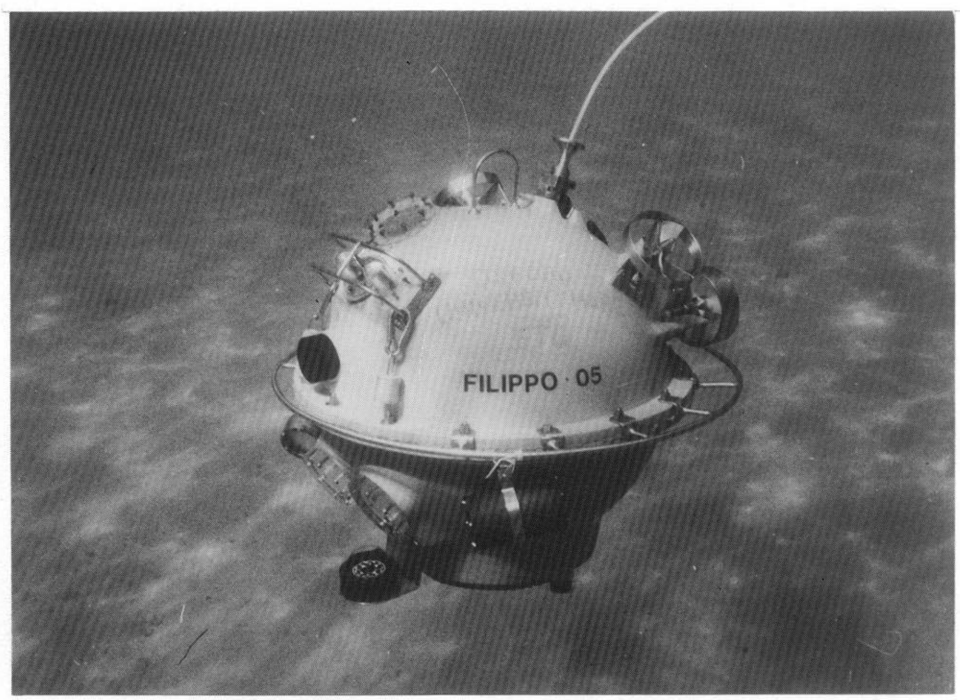
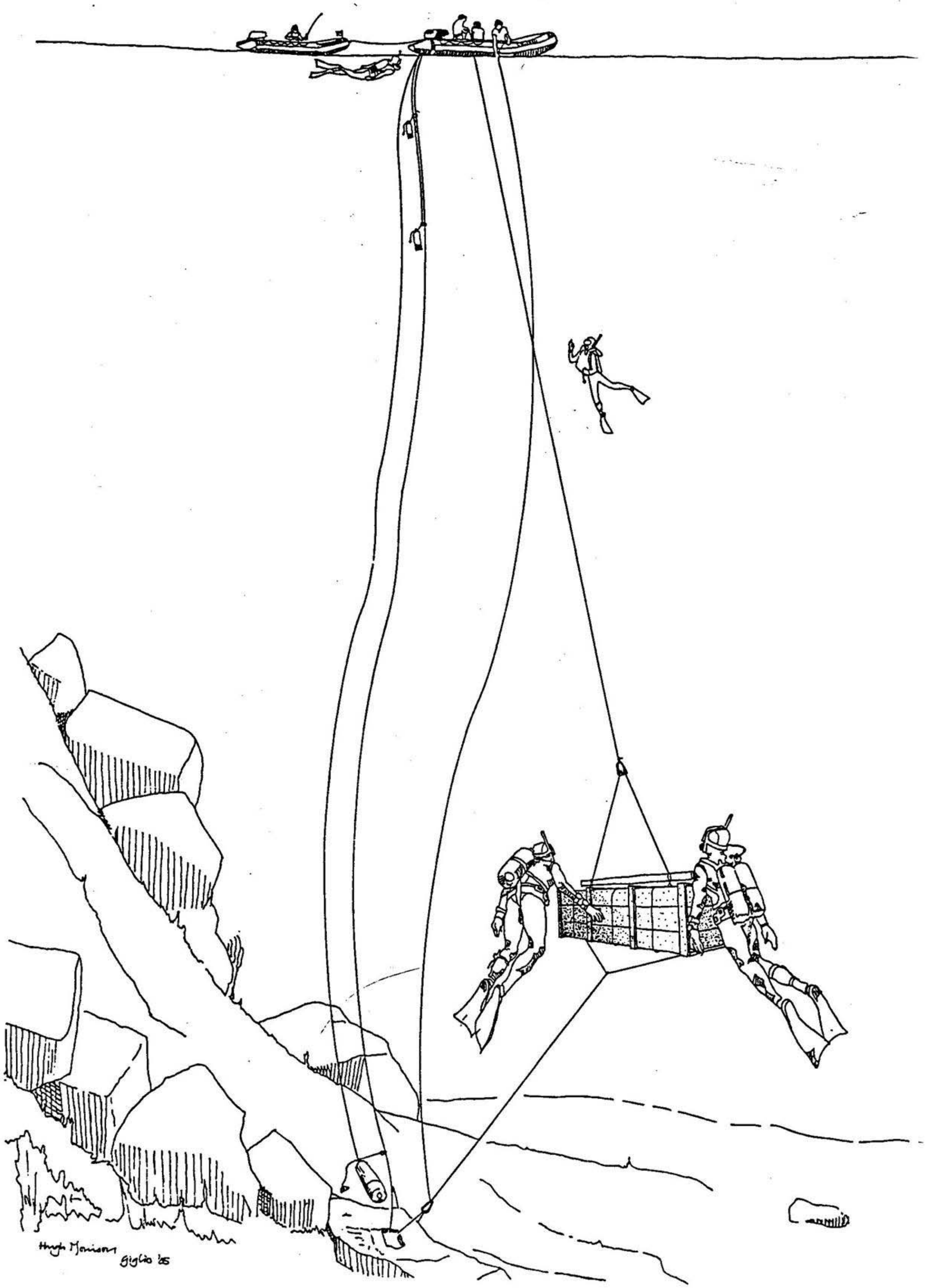


Figure 18a For deepwater searches a ROV (remote operated vehicle) can be helpful.

Figure 18b Divers descending to site with grid-irons *Figure 18b Divers descending to site with grid-irons*

Figure 19 A dive boat used by Oxford University MARE in their work.

Figure 20 It is helpful to explain a complicated operation with the aid of a diagram. Here we see divers raising a part of the Giglio ship's keel in a box (drawing by Hugh Morri son).



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CONTRIBUTORS

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One of the country's leading cave divers, and an experienced leader of many underwater expeditions. Former council member of the Underwater Association. Fellow of the Royal Geographical Society and New York Explorer's Club. In 1987, he received the first BSAC Colin McLeod Prize for outstanding contributions to international diving activities, and in 1989 was awarded a Churchill Fellowship to study international training techniques for cave diving. He has since died in a dive related accident.

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Mensun Bound
Archaeological Director of Oxford University MARE, trustee of the World Ship Trust and Falkland Islands Foundation. 1985-6 Diver of the Year in Italy. Mensun has been directing underwater archaeological expeditions for six years, including expeditions to Marsala, and the Mediterranean islands of Panarea, Giglio and Montecristo. He has recently begun work on an important 5th century BC wreck which sank carrying a cargo of fine-ware pottery. The wreck has the unusual distinction of having fetched up in the boiling mud of a live volcano.

Elizabeth Wood
A marine biological consultant, author and lecturer who has organised and participated in many marine biological diving expeditions and research programmes. She lived and worked in the Far East for several years and has also carried out marine biological diving projects in many other parts of the world. She works closely with the Marine Conservation Society and World Wildlife Fund on conservation-orientated projects.

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