BIOLOGY CURATORS GROUP

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Live Animal Displays in Museums - the Lower Vertebrates

Proceedings of the BCG meeting held at Coventry Museum on 25 September 1987: five papers on the legal and practical aspects of keeping amphibians, reptiles and fish for public display.

1 Law, Ancillary Documentation and Live Animal Displays

Gordon McG Reid, Keeper of Natural History, Horniman Museum, Forest Hill, London SE23 OPQ

Background

The Secretary of State for the Environment provides a list of over one hundred items of legislation of likely or possible relevance to a zoo operation (DoE, 1984). There are many more laws, codes of principles and practise and policy statements or guidelines which are not listed but which may have to considered in relation to captive wildlife, the staff who look after the animals and the public who view them. Museum curators with responsibility for live animal collections may, understandably, find these various, often voluminous and sometimes apparently contradictory documents difficult to comprehend and implement. This paper seeks to indicate and interpret some of the most important and recent literature in this rapidly developing field and anticipates likely areas for future legislation. Although much of the current regulatory literature is of general application, the group of animals particulatly referred to here are the 'lower vertebrates' - fishes, amphibians and reptiles.

Law and underlying principles

Law is a body of enacted or customary rules recognized by a community as binding. Although it may not always be evident, there is usually a definite principle upon which any particular law or code is based. The driving principle behind the confusing diversity of present zoo-related documentation is, of course, the welfare of animals in captivity. It is important to remain conscious of this and not to let the prime motive become obscured when reading through pages of dense legal terminology and official jargon.

Five main sub-principles can be discerned in the published literature, either separately or in various combinations. Two of these relate to the currently perceived 'public functions' of a zoo, ie Recreation and Education. A further two sub-principles can be distinguished regarding 'private or wider functions' ie Scientific Study and Wildlife Conservation. The remaining sub-principle concerns Health and Safety for the visiting public and for people employed by zoos. In short, the key aim of the legal or codified documents under discussion is to promote animal welfare, consistent with a zoo's public and concealed functions and the health and safety of visitors and staff.

Because the sub-principles mentioned above are interlinked, the individual upholding laws cannot be considered in isolation. Some of the definition of current zoo licensing legislation, for instance, comes from separate health and safety and conservation codes. While the underlying principles remain, it should be noted that with many legal statutes there can be subsequently appended modification orders and revised schedules which may alter the original intentions, coverage and application of the law. For example, the idea of what constitutes a 'wild', 'dangerous' or 'endangered animal' will change when particular species become added to or removed from existing schedules.

Law-making and the consultation process

From the above, Law is characterised as a body of rules or principles widely accepted by a community. In this particular context the 'community' is, essentially, those in museums and zoos involved in the management of live animals and also, ultimately, the employing authority (often a local or national authority but possibly a private body). Laws are usually made by (and modified or repealed by)

members of the community in conjunction with a legislative body (often acting for the government but possibly operating at a local or international level). Before a law comes into force there is usually a process of consultation between the legislative body or enforcing body and the community involved. Thus, current zoo licensing regulations (see below) came into force by an Act of Parliament only after an extensive process of consultation organised by the Department of the Environment and mediated through the National Federation of Zoological Gardens and other organisations. Similarly, the transfer of enforcement responsibility for the Health and Safety at Work Act in respect of zoos (see below) only took place after the Health and Safety Commission had circulated a consultative document containing draft regulations and guidance notes. Laws affecting live animal displays are thus, to some extent, what individual animal managers want them to be and 'bad' legislation or overly legalistic documents may simply be a result of apathy in that community and a lack of participation in the law-making process. There is certainly no reason to view the laws relating to live creatures on display as some kind of bureaucratic encumbrance imposed by a higher authority on animal managers.

Sometimes a main outcome of the sort of consultation exercise decribed above is policy statements, guidelines, recommendations, approved lists or other codified documents. This literature will often represent the 'spirit' of the statutory law and the customary practises to be associated with it; and so it will serve as a basis for interpretation. For example, the Zoo Licensing Act (see below) is itself a tersely worded eighteen page document; but the Department of the Environment provide at least ten other documents to assist in interpretation and implementation, including a Note on Environmental Education in Zoos and a bulky paper entitled: The Secretary of State's Standards of Modern Zoo Practise. Although such relatively informal documents can never serve as a legal substitute for the text of the Act itself (failure to comply is not necessarily an offence), the greatest opportunity for community participation lies in making a contribution to their formulation.

There would be few in the museum or zoo community who consider that every aspect of the management of living exhibitions is satisfactorily regulated at present. Vivarium keepers are, for example, regularly placed under pressure to accept into their displays red-eared terrapins Chrysemys scripta or large fishes such as pacu Colossoma nigripinnis. These are offered by members of the public who are no longer able to cope with their charge. This chronic situation arises from the unregulated bulk importation of these animals into this country (see section on 'conservation legislation', below). Certainly, the 'community' strongly disapproves of this lack of import control, but how many individual animal managers have expressed this view in writing to the Biology Curators Group (as a mediating body) or to officials of the International Branch, Department of the Environment who administer the laws concerning the import and export of animals?

The common consequences of a lack of individual and community action are that animals suffer and/or animal managers suffer. How often, for example, have we heard the complaint, among those involved, of the lack of a career programme and training structure for keepers of aquaria and vivaria in museums? Unfortunately, the Biology Curators' Group and its individual members were not conspicuous in their contribition to a recent Government report by a working party of the Museums and Galleries Commission entitled: Museum Professional Training and Career Structure. As a consequence, there is in that otherwise worthwhile report no consideration of the very special training needs of those who care for live animals in museums (HSC, 1984: 8) and of the difficulties in getting that training within the existing Museums Association framework. Let us all ensure, then, that an appropriate contribution is made to the Museums and Galleries Commission before the recommendations of their working party become Government policy and before certain principles derived from these recommendations become codified documents.

Primary animal welfare legislation

Much has been written on the subject of the law in relation to the basic welfare of captive animals and many aspects of this are well summarised by Sandys-Winsch (1978) and Cooper (1979a, b; 1980) and in a document published in 1976 by the Universities Federation for Animal Welfare. The Cruelty to Animals Act, 1876, is a venerable early item of legislation (enacted law) which is primarily concerned with the welfare of captive animals undergoing experimental treatments. Lower vertebrates would here be included in the concept of 'laboratory animals'. It is unlikely, however, that experimental procedures of the sort likely to raise questions of cruelty would be conducted in a museum zoo situation. Benign investigations such as breeding programmes, which do not involve marked discomfort, would not be regarded as 'cruel'; but a study on feeding which involved starvation could be seen as 'cruel' . The use of hormones by injection to induce spawning would, however, not normally be interpreted as cruel in that the action of the hormone is predictable, the procedure relatively painless and the outcome 'natural'. The Animals (Scientific Procedures) Act, 1986, demands an assessment of pain, distress or discomfort so that rational conclusions can be drawn over acceptable levels. Methods of estimation are now under review by the BVA Animal Welfare Foundation.

The protection of Animals Acts, 1911-1964 are more broad-ranging than the Cruelty to Animals Act; they allow for more severe penalties for infringements and they protect both domestic and captive wild animals. They proscribe intentional cruelty or that resulting from an act of omission (eg a failure to provide

appropriate shelter for a reclusive species). The intention is evident that a captive wild animal should not suffer as a result of its confinement. More recently, the Abandonment of Animals Act, 1960, legislates against leaving an animal in an uncared for situation which is likely to cause unnecessary suffering. In this context, a failure to feed or water livestock over a weekend could possibly be interpreted as 'abandonment'. The Veterinary Surgeons Act, 1966 has important animal welfare implications for animal managers in museums. This Act requires appropriate veterinary consultation and treatment if a mammal, bird or reptile falls ill. Fish and amphibians are not included in this reserved group and so, here, the animal keeper apparently has the right to treat a sick charge without recourse to a veterinary surgeon. This would accord with the customary situation where the animal keeper has acquired a specialised expertise in disease recognition and treatment, whereas the veterinary surgeon will often have a limited knowledge of sickness in lower vertebrates and of the remedies available to effect a cure.

Legislation and the proper conduct of zoos

By far the most important piece of legislation directly affecting live animal displays in museums and zoological gardens is the Zoo Licensing Act. This is 'an Act to regulate by licence the conduct of zoos'. It came into force on 27 July, 1981 and it applies to all of mainland Britain but does not extend to Northern Ireland. It contains twenty-three sections concerning the licensing process, the Secretary of State's functions/standards, inspections, special cases, fees, enforcement and supplementary information. Fundamentally, it concerens all of the five underlying principles stated above. These principles have a wide international acceptance and they are already embodied in codes produced by the Federal Zoological Control Board in the United States of America (Pronek, 1976).

The detailed implications of the Zoo Licensing Act for museums with live animal displays have already been discussed by Reid (1984). It is now a declared aim of the Biology Curators' Group to (section nine): 'promote advances in the display and maintenance of living museum collection (zoological and botanical). In the case of live animals, to conform with the Secretary of State's standards for zoo licensing which require a high level of husbandry and which emphasise the role of licensed establishments in recreation, education, scientific study and conservation (captive breeding)' (Stansfield, Mathias and Reid, 1987).

By now, all museums which house a live animal display, however modest, should (following an application and inspection process) either be licensed as a 'zoo' under the terms of the Act or have been granted an exemption. If neither course of action has so far been taken then the museum or the employing authority (the putative 'zoo operator') is guilty of an offence and is liable to prosecution. It should be stressed that exemption from the provisions of the Act cannot be presumed - it must be applied for.

The debate over exemption from zoo licensing

The question of whether an institution should go for licensing or for an exemption has provoked considerable debate in museum circles and different institutions have adopted different policies. For example, the Herbert Art Gallery and Museum, Coventry, applied for an exemption, while Bolton Museum and Art Gallery, Merseyside County Museums and the University of Manchester Museum all went for licensing. The Horniman Museum, London, initially applied for exemption and then, following a change in policy, sought a licence. One advantage of this mixed approach by museums is that firm precedents have been established for both options and so, in the future, no single museum should be forced to adopt a course of action in licensing which does not suit institutional policies. Whereas Reid (1984) strongly advocates licensing, an excellent summary of the case for exemption (and the advantages and limitations imposed by the granting of it) is given by Wright (1985). However, both authors are agreed that, even in instances where an exemption is applied for and gained, the Secretary of State's standards for licensing should still in large measure apply for the ongoing management of the unlicensed facility. Exemption is no excuse for shoddy displays, a lack of educational interpretation and poor quality animal husbandry.

In cases where the living displays are of a relatively limited size and scope, there may well be economic and administrative advantages in gaining exemption - as indicated by Wright (1985: 66; 1987: 137). But, for a small facility, the excessive costs of a full inspection can be radically reduced by applying (under section 14.2 of the Act) for a dispensation. Applications for an inspection limited under section 14.2 must first be channelled through the Department of the Environment. The DoE may, in turn, advise the Local Authority that sections 10.4a and 10.4b shall not apply. It would, however, be unlawful for an exempted (unlicensed) establishment then to develop an active role in research on and conservation of endangered species through captive breeding (two prime functions of a properly constituted zoo); or to afford such species shelter, were customs authorities to offer animals seized as illegal imports (as quite commonly happens).

A major reason for becoming licensed is the gaining of 'official status'. Official status is of value in formally reassuring members of the public, the media and animal welfare groups that the holding establishment accepts and conforms with currently accepted high standards. It should be understood that an exemption is always liable to be reviewed. An advantage for the curator employed by a licensed institution is that he or she has the opportunity fully to develop displays and adopt a wide-ranging livestock acquisitions

policy without the lingering fear of possible infringements of the Act. Very importantly, an otherwise reluctant employing authority may be galvanised into making funds available for any development or refurbishment work necessary to meet their statutory responsibilities in licensing. Last, the issue of 'animal rights' is now a subject for hot debate (see Lewisham Animal Charter, 1984) and there is now a growing public and official scrutiny of zoo set-ups and, in some cases, a pressure for their closure. It is a particular advantage here to have a license as a formal bulwark against actual and potential critics.

Health and Safety legislation

Common sense, morality and ethics dictate that no live animal display should be mounted which poses a real threat to the health and safety of the animals, the zoo-keeping staff or the viewing public. This basic principle is embodied in the Zoo Licensing Act (above), in the Dangerous Wild Animals Act, 1976 and in the Health and Safety at Work etc Act, 1974 - all of which laws operate in concert. The most immediate and obvious risk to staff and public are dangerous wild animals. Venomous reptiles (usually exotic snakes) pose a most obvious and dramatic threat, owing to their ability to escape and survive outside their enclosure. Animal managers holding such creatures should be acutely aware of their responsibilities under current codes (eg see HSC, 1985, para 53). The Department of Health and Social Security in document HN(86)9 updates the guidance (originally provided in HN(78)13) on the arrangements for the supply of snake antivenoms for treating foreign snake bits. A paper on the nature and availability of 'emergency drugs' (Meredith, Caisley and Volans, 1984) should be read in conjunction with the DHSS guidelines. It should be noted that, where an institution has been granted an exemption from zoo licensing, it cannot normally act as a holding facility (temporary or permanent) for venomous or otherwise dangerous animals (as scheduled under the Dangerous Wild Animals Act) such as may be occasionally referred to a museum by customs, police, the RSPCA and fruit importers. Should there be a requirement to hold any dangerous creatures in a 'zoo-exempted' establishment then a separate licence could be applied for under the Dangerous Wild Animals Act. The Horniman Museum Aquarium and Vivarium, for example, was until 1985 licensed under this Act by virtue of the presence of spectacled caiman (Caiman crocodilus).

The Dangerous Wild Animals Act and the HSW Act adopt slightly different views as to what constitutes 'dangerous; or 'hazardous' and this is an area for concern and, hopefully, reform. For instance, the deadly venomous stonefish Synanceja trachynis is, presumably from its lack of mobility and its usual containment in an aquarium, not scheduled under the Dangerous Wild Animals Act. But such an animal does not have to escape to be very hazardous and its cryptic colouration makes it a particular danger to those having access to its tank. A careless or naive member of staff or a curious member of the public could possibly die if accidently envenomated (Weiner, 1958; Southcott). Certainly, accidents (fortunately minor) involving venomous fishes other than stonefish have occurred in museum and zoo circles in the past. Probably in broad recognition of this infrequent sort of circumstance, the concept of 'hazardous' in HSW terminology would include venomous fisehs as well as scheduled dangerous animals. Aquarium and vivarium managers should be aware that newly formulated antivenoms are now available for a wide range of lower vertebrates, including stonefish. The Horniman Museum Aquarium, for example, displays stonefish and holds a specific antivenom, obtained from the Commonwealth Serum Laboratories, Melbourne, Australia.

Most animal managers are far more likely to be electrocuted than envenomated and the perilous state of 'non-splash proof' or salt-encrusted electrical installations in many public aquaria and vivaria is well known to those staff placed at risk. There is a real need, here, for biology curators to press for mandatory high safety standards to apply to electrical installations. There is, for example, as yet, apparently no legal requirement to install residual current circuit breaking devices (RCCD's) and yet severe injury or loss of life could easily result from their omission from a circuit.

The Health and Safety at Work etc Act, 1974 is the primary legislation concerning human health, safety and welfare at zoos. The HSW Act, however, would in this context now be interpreted through the Health and Safety Commission Document: Zoos - Safety, Health and Welfare Standards for Employers and Persons at Work. This recent paper includes 59 sections which deal with topics such as: enclosures for hazardous animals, access provisions for enclosures, systems of work, escapes of animals, instruction, training and supervision of staff, veterinary procedures and aspects of basic health, welfare and sanitation. Matters of routine hygiene often seem obvious, and so a sensible member of staff would normally wash his hands following any risk of exposure to disease (eg Salmonella from reptiles) (see HSC, 1985, para 51). But how many operatives adopt customary veterinary procedures and carry out this operation using a powerful bacteriacidal soap (eg 'Hibiscrub') and use a scrubbing brush which is less than three months old? Also, how many animal managers are aware that routine monitoring of bacterial and fungal contamination of water (fresh and salt) can now easily be carried out using commercially available 'dipslide' tests? The standards for tapwater are already subject to international agreements and so one can anticipate that in the case of aquarium and vivarium water quality, specific permitted levels of recirculated or standing pollutants (eg ammonia, nitrite, nitrate, phenols) will eventually be introduced (eg see Franks, 1985).

The disposal of animal waste, post-mortem material and clinical wastes (swabs, scalpels,

needles) is also an area for increasing regulation. An acute public awareness of the fearsome risks of being pricked or cut by a contaminated needle or scalpel has only developed in the last few years. The environmental health departments of some local authorities may be willing to organise a special waste collection service, while in other circumstances private veterinary incineration companies may oblige. For some years there has been a high level of concern over incidents arising from the handling of such material and guidelines now exist on safe procedures, including the colour coding of bagged waste (HSC, 1982). The procedure for the disposal of waste from veterinary and allied establishments is apparently still under review by the Department of the Environment and other bodies (Oakland, D and Hooper, J, 1985).

Legislation and nature conservation

One of the declared objectives of the Biology Curators' Group is (section 9): 'To review and to seek to improve the ways in which natural history museums provide a service to the community including their role in disseminating information about the natural environment in conservation education.' (Stansfield, Mathias and Reid, 1987). Echoed here are the recreational, educational and conservation principles which underpin current zoo legislation. More than any other category of biology curators, animal managers in museums and zoos are uniquely placed to communicate conservation issues to the public through stimulating and dynamic living displays, particularly those which involve the products of captive breeding. The role of captive breeding as a major strategy in the conservation of fish species is stressed by Maitland and Evans, 1986, who also note that: 'despite the interest shown by zoos in the captive breeding of threatened mammals, birds and reptiles, little interest has been shown by public aquaria (including those maintained by zoos) in the breeding of threatened or rare fishes'. Indeed, few public aquaria which responded to a survey by Evans, 1982, showed any enthusiasm for displaying fishes of conservation importance or of breeding from them.

There are some signs of widespread and growing concern over the above problem. The Species Survival Plan of the American Association of Zoological Parks develops strategies for the conservation of lower vertebrates (McClain, 1985). This year (1987), for the first time, a proposal will be raised at a symposium of the European Association of Aquarium Curators (Löbbecke Museum and Aquazoo, September) to establish a programme for the captive breeding of fish, amphibians and reptiles. Similarly, the 2nd International Congress of Aquariology (Monaco Oceanographic Museum, February, 1988) are adopting 'conservation' as one of their conference themes. Last, as part of an international scheme, a Fish Rescue and Breeding Centre has been established at the Horniman Museum Aquarium to tackle some problems in the conservation of the endangered cichlid fishes of Lake Victoria (Reid, 1987). However, the ability of this and other zoological institutions in Britain to offer shelter and accommodation to endangered or vulnerable lower vertebrates, to study them, breed from them and (where ecologically viable and desirable) to re-release to the wild, is now dependent on these institutions being properly licensed as a zoo (see above). There is also a requirement, here, for live animal displays to conform with the current relevant conservation legislation.

In the absence of captive breeding programmes, animal managers must ever look to wild stocks to replenish or develop their living displays. The removal of wild animals from their natural habitat simply for exhibition purposes poses considerable moral, ethical and, ultimately, legal problems. Limitations on re-stocking from native populations of lower vertebrates are given in the Wildlife and Countryside Act, 1981. Displays of sand lizards Lacerta agilis or midwife toads Alytes obstetricans, for instance, could not now be mounted without special permission (CoEnCo). The detailed implications of the Wildlife and Countryside Act for museums have already been the subject of a joint Biology Curators' Group/ Museums Association seminar held at the British Museum (Natural History) in 1982 and reported on by Stansfield (1983). There is also a useful summary of this Act given by the Nature Conservation Council (1982).

The animals on display in most museum aquaria and vivaria will often be exotic in origin and have been imported into this country. In order to import live freshwater fish it is necessary to obtain a licence under the Diseases of Fish Act, 1937 (as amended under the Diseases of Fish Act 1983, c 30). An application form for this purpose (DO7) can be obtained from the Ministry of Agriculture Fisheries and Food. The importation of certain species of fishes (though not freshwater tropicals or marines) will require an independent health certificate. A health licence does not remove the necessity to obtain a conservation import licence for the fish specified in Part 2, Schedule 1 of the Endangered Species (Import and Export) Act, 1976. In this connection, applications should be directed to: Department of the Environment, Wildlife Conservation Licensing Section, Tollgate House, Houlton Street, Bristol BS2 9DJ. It is an offence, under the Wildlife and Countryside Act, to release or allow to escape into the wild any fish or eggs covered by any of the above licences. A licence to effect such a release under this Act can, however, be obtained from the Ministry of Agriculture and Fisheries.

Trained personnel to carry out rapid and accurate identification are crucial to the exercise of import regulations and other legal controls over the content of live animal displays. Wright (1985: 63) has already pointed up perceived shortcomings at the Department of the Environment with respect to taxonomic expertise. Competent herptile and fish taxonomists (quite likely museum

employees or government officers with museum training) need to be readily available to scrutinise shipments at the point of entry. Until this happens, unscrupulous livestock traders will be able to flout the law, almost with impunity. Also, the British Veterinary Association Animal Welfare Foundation consider that there is a prime need to review and consolidate the lengthy and complex legislation relating to the transport of animals into the country and within the country and it is understood that the Ministry of Agriculture and Fisheries will undertake this task. With new legislation and close monitoring, the often high mortality rate among imported lower vertebrates could be reduced to a minimum.

International wildlife conservation is an area for increasingly strict regulation and, as crises develop in nature, zoological establishments can expect many revolutionary new laws or codes or modification orders which will restrict or ban the supply of particular wild animals. It is, for instance, easy to anticipate increasingly tighter controls being placed on the (presently unrestricted) bulk importation of common tropical marine fishes, following a recent report on the exploitation of coral reefs for the aquarium trade (Woods, 1985). It is certainly difficult to justify the continued importation of common but highly specialised coral feeding fishes which will undoubtedly starve in an aquarium and cannot be bred from. It is important to establish the principle that an animal which is not endangered or vulnerable in nature may still require protection by virtue of the difficulties involved in maintaining it in captivity.

Much of the pace, direction and content of global conservation law is set by the International Union for the Conservation of Nature. This organisation, which is the scientific 'twin' to the World Wildlife Fund, has a Commission on Law and Administration and it also supports an Environmental Law Centre in Bonn, West Germany, where conservation legislation is monitored. The IUCN Species Conservation Monitoring Unit in England is, among other roles, responsible for the production of the famous Red Data Books - which are international registers of threatened species (see eg Miller, 1979, for fishes and IUCN, 1982, for amphibia and reptiles). These registers are now used as schedules for the 1973 Washington Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and the Migratory Species Convention.

The Conventions may be used to frame European Economic Community directives and to interpret or implement UK conservation legislation which, ultimately, has a close bearing on the proper operation and management of live animal displays in museums. The IUCN Commissions, for their policy making, strongly rely on information provided by their Specialist Groups. The Species Survival Commission, Fish Specialist Group is, for example, now preparing a worldwide strategy for fish conservation (Maitland in MS). Such Specialist Groups depend, in turn, on the expertise, assistance and support of volunteers which often include museum personnel. There is, then, an ever present opportunity for biology curators involved with living displays to promote or prompt helpful new legislation and codes or suggest ways to better utilise the powers under existing legislation.

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Bolton Aquarium - its History and Development

2

T. Henshaw
Bolton Museum

The technical aspects of keeping fish are advancing at an alarming rate, so that equipment used today very quickly becomes obsolete. This causes various problems in an established museum aquarium.

Bolton Museum Aquarium was built in the 1930's to a design similar to that at Chester Zoo. On completion there were sixteen display tanks and five quarantine tanks. The fascia was tiled and a brass rail kept people away from the front glass. During the 1970's, when the aquarium was given a facelift, the rail was removed and a new fascia was erected in front of the existing tiled one. Although this allowed people to get 'closer' to the fish, it also allowed diamond rings to scratch the glass, graffiti to appear on the fascia, as well as the inhabitants having to suffer the sudden shock of people thumping the glass. The facelift, therefore, was not necessarily an improvement.

Originally each tank had limestone rockwork cemented in place. This produced two very useful results. As the tanks are made from reinforced concrete the act of cementing in rocks effectively sealed them from leaching carbonates into the water. This extended the life expectancy of the concrete. Also the limestone, being white, reflected the light back into the tanks making them appear very bright. The one drawback was that all the spaces behind the rocks were filled with gravel and this created an area which could not be effectively cleaned.

The filtration system employed at Bolton consisted initially of wooden filter boxes in which there was some medium - gravel/filter floss. The boxes were probably sited under the display tanks and water entered them by gravity feed and was then pumped back into the tanks. This was altered during the late 1960's and the filter box, now of plastic design, was sited above the tank and a submersible pump employed to move water from the tank to the filter box. The filter medium now being used is one of the following: foam, filter floss and gravel or filter floss and bio granules. It is still not fully satisfactory and it is hoped to improve it again in the future.

From the time of opening until the mid 1960's the aquarium tanks were all connected so that water could enter at one end of a run of tanks, percolate through to the other end and then leave and run away to drains. This is known as an 'open' system. By and large it can be a very effective system when operated competently. However, because most museum aquaria are considered low priority, inexperienced staff are often employed and there is an initial period when experience is being acquired when things can go wrong. Unfortunately during the 1960's things did go wrong on a major scale and quite a lot of the

livestock were lost. This resulted in the change of filtration, removal of a lot of rockwork and the isolation of each tank.

The rockwork was replaced with sheets of darvic as a temporary measure; the sheets are still used today - twenty years later!

Sometime during the 1960's one section of the aquarium was used to display native marine life. Unfortunately salt water rots concrete quite quickly. These tanks soon developed leaks and were then used to display reptiles, until the mid '70's when they were repaired and a fibreglass skin installed to prevent leakage. Twenty years on and the rest of the tanks are undergoing the same problem. It is hoped that they can be treated and have a glassfibre skin inserted to increase their life by about 10-15 years.

In the 1970's, when the fascia was altered and the rail removed, the static display in the corridor leading to the aquarium was converted to include aquaria; six tanks, 5ft x 1.5ft x 1.5ft, were installed. This effectively increased the number of tanks from 16 to 22. It also added scope so that more small fish could be displayed - the smaller fish are often lost in a large tank eg. 8ft x 3ft x 3ft. Unfortunately this area was full of compromises and the design leaves a lot to be desired. Because of the relative shallowness of the tanks and the height at which they are installed, small children have difficulty seeing in them and adults have to stoop. There is very little space for access to the tanks and all maintenance work is carried out from the display side. Consequently this is done before 9.30am when the aquarium opens. There is also a problem with the keyholes getting filled with pencils, pens and chewing gum, so getting into the tanks can sometimes take a long time.

The tank lighting has over the past few years gone through quite a lot of changes. Initially there were incandescent bulbs; these were changed to fluorescents, which were then altered to splash-proof fittings - part of the Zoo Licence conditions. It is hoped eventually to change again to spot lamps because these focus the light on the tank whereas fluorescents give a 360 degree spread. Spot lights will create a heat problem but this should be nullified by altering the air circulation through the aquarium.

The aquarium is predominantly fresh water. Approximately ten of the tanks are tropical and consequently require heating. Until very recently this was done using a number of domestic heaters connected to a contactor which was switched on using a domestic thermostat. Because a large number of heaters were used they burned out regularly and it was time-consuming searching out the offending heater. The domestic heaters were therefore replaced with industrial units of 1 or 2kw capacity.

When the conversion was made from domestic heating to industrial heating it soon became apparent that the power supply to the aquarium was insufficient. At present ten tanks require heat; total demand, based on 1kw requiring 4.2 amps, is in excess of 60 amps. As only 25 amps are being delivered, some tanks are not heated all the time. The building is at present being surveyed for rewiring which, hopefully, will take place in 1988.

In 1985 the Bolton Aquarium was inspected for the Zoo Licence. This involved a team of inspectors from the Department of the Environment and from the Environmental Health Department inspecting all aspects of the aquarium. They decided to grant a licence but only conditionally. The two conditions were that

i) electrical fixtures be altered to splash proof fixtures and earth leakage circuit breakers be fitted to all circuits, and
ii) that intensive records be kept of all occurrences so that in the event of staff illness the fish would still be maintained in the correct manner. The inspection proved very useful in that the inspection team made a number of suggestions, observations and recommendations which helped tremendously with the husbandry of the stock.

The main feed for fish is oxheart. This is given three times a week. The oxheart is bought fresh. It has the outer and inner membranes removed and is then cubed and dusted with vionate vitamin powder. Some of the cubes are then minced and it is then fed to the fish.

The inspectors were concerned that the vitamins would wash off and would not get into the fish. They suggested liquidising the heart and setting it in agar with the added vitamins. Unfortunately agar is quite expensive so gelatine was preferred. This was used for twelve months during which time it became obvious that the fish were losing weight and condition. As the larger fish chewed the cubes of gelatine/heart/vitamins, a large proportion of the feed was squirted out through the gills into the tank, creating a soup with which the filters could not cope. So the gelatine was dropped and for the time being feeding has reverted to the original method. However, more of the commercial feed has been introduced into the diet in the hope that the fish will ingest more vitamins.

Concern was expressed by the inspection team about the condition of the concrete tanks. They are showing signs of 'concrete cancer' and are spalling badly. Because of this concern an inspection was carried out by a concrete specialist. The report stated that although there was no danger of tank collapse, repair work should be carried out soon.

The acquisition of new fish poses the problem of stress. In imported fish the long journey and the changes of water chemistry (exporter to importer/wholesaler to final home) can be extremely stressful. The large dealers' tanks often leave a lot to be desired and some colleagues prefer to either import their own

fish, which is fairly risky or to take them from the wholesaler as soon as possible to reduce the chance of new arrivals being diseased.

Wild caught fish have the additional problem of getting used to alien conditions. For native fish, stress can easily be reduced by careful handling and by using oxygen and a mild tranquillizer eg MS-222.

At Bolton MS-222 is used to quieten wild caught native fish. This, coupled with careful handling, has reduced deaths in transport to virtually nil. A stock solution is made up so that 100ml of solution holds 450mg of tranquillizer; 10ml of stock solution added to 1 gallon of water will give approximately 45mg/gallon. According to D J Solomon and A D Hawkins[1] a concentration of 10-30 mg/l is sufficient to tranquillize fish.

As there are 4.5 litres per gallon then 10ml of stock solution added to 1 gallon gives the lowest concentration. Note this is only used in transport; prolonged exposure to MS-222 can lead to respiratory problems.

During the next few years it is hoped that Bolton can join the Lake Victoria cichlid scheme to preserve fish stock native to the Lake. It is also hoped that the two pairs of freshwater stringray, at present housed in the aquarium, will attain sexual maturity and start breeding.

References

1 Hawkins, A D (ed), 1981. AQUARIUM SYSTEMS. Academic Press

3 The Management of Temperate and Tropical Marine Displays

M D Murphy, Cons Cert, C Biol, M I Biol.
National Museums and Galleries on Merseyside

Introduction

Liverpool Museum has a long tradition of living displays. For example, the 5th Annual Report for 1857 states that:

"During the year several aquaria, both salt and freshwater, have been established in the Museum and have proved objects of very great interest to visitors; indeed, there is good reason to suppose that it is mainly owing to the new additions to the Museum that the number of visitors has been so much in advance of previous years."

The 'advance' referred to was an increase of no less than 16,145 visitors over the previous year's total of 106,914.

We are particularly fortunate that this tradition continues to receive the backing of the museum's management team who are prepared to underwrite the considerable effort and resources necessary for the upkeep of the displays. The result is that some 130 years on, live displays remain at the forefront in the popularity stakes, and continue to play an important role in the Museum's educational programme.

Display techniques

Management of large-scale marine displays requires, above all else, an ability to keep a host of disparate elements in relative equilibrium at all times. Whilst attempting such a biological balancing act, usually within the confines of a multitude of aquaria, one must also be constantly mindful of the needs not just of the inmates, but of the observers as well. After all there is little point in providing optimum conditions for your favourite species of burrowing goby if all the visitor has to look at is an occasional cloud of mud and a hundred-word label! The most successful living displays should have immediate aesthetic appeal and educational impact. This can only be achieved through excellent presentation supported by dedicated staff with access to comprehensive maintenance facilities.

The present aquarium and vivarium replaced the original one which was destroyed in the last war, and was first opened to the public in March 1966. Unfortunately, from the outset it suffered from the effects of poor design in several important areas. The 26 rectangular display aquaria were of mild steel construction and their internal resin coating soon chipped off, causing corrosion problems. The light level achievable over displays was inadequate and the safety of the installation questionable.

Large but inefficient sand filters, located below floor level, required the laborious removal of floor boards in order to inspect or service. Only twelve small aquaria were provided for quarantine purposes. They were located in a 10ft x 10ft room which also doubled as an office, enquiry point and store. An ambient temperature in excess of 30°C (86°F), caused by uninsulated sub-floor steam pipes, frequently resulted in 'cold water' displays operating at temperatures higher than those found in the tropics.

Fortunately, most of these problems are now things of the past. We have full quarantine and breeding facilities of over sixty tanks contained in two rooms. On the west display gallery the ambient temperature is maintained at 20°C (68°) by four individual air-conditioners and the water temperature of the thirteen local marine and freshwater displays is further reduced to 10°C (50°F) by a titanium cooling plant of advanced design.

The east gallery is fitted out with thirteen marine and freshwater display tanks which contain a wide range of tropical species. High-tech backup includes automatic photoperiod control, emergency power supplies to essential equipment, dual circuit air turbines, UV water irradiation equipment and

a fully-equipped cold room. We are about to embark on the final phase of replacing the corroded display tanks with lightweight, free-standing fibreglass tanks and integral biological filters, all built to our specification.

Having got the basic infrastructure right, we have been able in recent years to concentrate on improving the scope and content of several existing displays and have created many entirely new ones, developed around specific themes. Topics of local interest such as the Wreck of the Mary (Charles II's yacht, discovered in 1971 off Anglesey) and New Brighton Pier are particularly popular themes, together with natural habitat reconstructions such as Anglesey Rocky Coastline and Hilbre Island Sandy Shore. We were greatly assisted in their production by model-making colleagues from the Technical Services Department, who helped us not only to translate our ideas into reality but also to develop our own techniques in using a wide range of 'new generation' plastics and rubbers.

Creating some displays occasionally involved us in field work. For example, the rock-effect backs in several tanks, which only occupy 2-3 inches of space yet create an impressively 'massive' backdrop, were formed from 45ft long by 5ft wide latex rubber moulds made in the geographic areas depicted in the displays. On one occasion two days' work was almost lost due to gale-force winds tearing half of the mould from the rock face overnight - fortunately we were out at first light and retrieved the pieces!

Other items, such as ships' timbers and bronze cannon, unsuitable in themselves because of their toxicity in closed seawater systems, were reproduced in fibreglass, along with several cannon balls and 'pieces of eight'. The overall appearance is so effective that the majority of visitors remain unaware of the deception and of the effort we have put into achieving it! The less obvious benefits of man-made structures include being very easy to sterilise should disease occur, being light in weight, easy to move, and totally non-toxic. Furthermore several tons of rock and other display materials can be replaced by such structures in each tank, and the resultant increase in space is of great benefit to the occupants, which have responded with improved colours, reduced aggression and more successful spawnings.

Our efforts to enhance the aquatic environment have had another important result. The displays now fully comply with one of the requirements of the Zoo Licensing Act (1981), which states (Standard no.9):

"In the case of aquatic animals, materials such as weed, shingle, etc [are required] to aid and encourage normal behaviour patterns among them."

Display lighting has been greatly improved by the use of metal halide lamps, and near-perfect colour rendition is now easily achievable. They are also powerful enough to stimulate the growth of the smaller green algae such as Enteromorpha and Caulerpa. They also improve the health of anemones, which rely on their symbiotic allies, the zooxanthellae, for an important and irreplaceable part of their nutrition.

Many of the larger species of seaweed play a crucial role in the natural environment, yet in display work they are virtually impossible to cultivate successfully alongside fish and invertebrates. We are therefore perfecting a technique for producing replicas and so far have been most successful with Laminaria saccharina, L. digitata and several Fucus species. However, we still have to improve the colours and find a way of creating 'buoyancy without bubbles' which would enable us to tackle some of the 'green' and 'red' algae as well.

Perhaps the most ambitious and exciting experiment yet undertaken will, on completion, result in far more realistic displays of tropical reef communities than previously possible. The idea for such a scheme first came to me in 1979 whilst studying coral reefs in the South Pacific. I was lucky enough to spend ten days on Green Island, situated on the Australian Great Barrier Reed 17^{O} south of the equator near Cairns. For the first time I was able to observe at close quarters hundreds of fish and invertebrate species previously known to me only through studies made in aquaria.

The experiment brought to mind an observation made by the famous naturalist Philip Henry Goss in 1865 in his book A YEAR AT THE SHORE.:

"He who has never seen marine animals except in the confinement of an aquarium, cannot but be conscious of many chasms in his knowledge, which are filled up by him who is in the habit of collecting his own specimens in their proper haunts".

Nothing could have been more true. On joining the reef inhabitats in their own environment, it became increasingly obvious to me just how impoverished were even the best man-made marine displays, and how garish and out-of-place the few reef creatures they contained.

Here, the numerous and brilliantly-coloured inhabitats harmonised perfectly with the equally gaudy and exotic backdrop of the living reef and the multitude of sessile forms which covered it. Here, then, was the way forward in marine display work. A method had to be found of reproducing the principal and most colourful reef inhabitats, such as corals, sponges, clams and algae and assembling them into 'mixed media' displays of living fish and invertebrates.

So far we have identified several major families of reef-building corals, gorgonians and sea whips and obtained suitable specimens from old collections. Their in-life colours have been established and accurately reproduced by the use of specialised pigmented plastics. Life-like models of the giant clam, Tridacna, have been made and several

prototypes produced. Work will soon start on some of the more robust calcareous algae such as Halimeda and various sponges. Such work is fascinating but time-consuming, not least because all materials used have to be tested in aquaria behind the scenes to ensure their suitability. It was at this stage that some novel problems arose. For example, we soon discovered that many species of fish attempted to eat the more life-like algae and corals and steps had to be taken to toughen them up, thus preventing all but the most persistent and best-equipped of them, such as Triggers and Parrotfish (which will be kept in other displays) from coming to an untimely end through blocked digestive tracts.

The numbers of species (370) and specimens (1460) currently on display have been deliberately depressed in order to minimise the considerable upheaval which inevitably results whilst producing new displays. However, once these are completed we will be able almost to double the number of species and include many unusual or demanding species never previously displayed at Liverpool. By so doing we hope to secure our position at the forefront of public aquarium display management, at least for the forseeable future, if not for the next 130 years!

Acknowledgements

My thanks are due to my colleagues in the Technical Services Department of the Liverpool Museum - Alan Dodson, Pete Spinks and Bill Sillitoe - for their skill and artistry in helping to prepare the displays. I am also grateful to John Edmondson, Keeper of Botany, for his advice on the preparation of this article at short notice.

4

Vivarium Design for Public Display

Nigel Platt
Cotswold Wildlife Park

Displaying reptiles and amphibians for the public is not as easy as creating decorative vivariums, or basic vivariums for the home. When a display is set up for public viewing, there are three main considerations:

1 the animals - it has to offer security, be hygenic, and have the correct furnishings for the species;
2 the keepers - the cage must be easy to service, must not be time consuming, and arranged so that the minimum disturbance is caused to the animal;
3 the public - the cage must be presentable, and be as aesthetically pleasing to the viewer as possible.

When creating a vivarium from scratch, it helps to have some idea of the intended stock, then the cage can be designed accordingly. There will have to be an area for water. This can be in the form of a shallow dish, or a 'sink' type pool, that can be emptied by removing a plug. The 'sink' type pool is easily emptied and filled in a short space of time; it also makes cleaning out reptiles easier as they have a habit of defecating in the water. The pool should have a good drainage system, which can be easily serviced if necessary.

The first step in decorating an empty cage is to paint the walls. Emulsion paint provides an ideal wall covering, and there is a good choice of colours. Soft colours or pastel colours work best as they do not distract the viewer from the animal being exhibited.

The rockwork of the cage has to be planned carefully as this is normally a permanent fixture. Some rockwork can be cemented in position, so as not to cause any injury to the livestock. Local stone can be used to keep the budget down, and can be disguised by mixing garden pond sealer with cement colouring, which also helps protect the rockwork from strong reptile urates.

When making the rockwork, remember to slope it slightly so water will run into the pool when it is washed down. Small crevices and difficult angles cause problems as they are hard to clean.

Having created a base to work on, four other points have to be dealt with: substrate, furnishings, heating and lighting.

1 Substrate is probably one of the most difficult points to get right; there are various options:

1a sand is very fine and difficult to keep clean, when the animal is feeding it can consume small quantities which build up and cause impaction in the stomach;

1b soil cannot be kept clean, so frequent changes are necessary
1c peat, like soil, cannot be kept clean, and it is likely to harbour parasites and disease;
1d leaf litter also cannot be kept clean, but it is a good medium for nervous ground dwelling species, so long as it is changed frequently;
1e gravel is by far the best substrate, because it is easily removed and washed and is available in a variety of colours and grades. The smallest grade I would advise for use is 7mm; anything smaller could be consumed by the animal. For larger snakes, such as the pythons and boas, large pebbles are best.

2 Furnishing - the loose fixtures that are placed in the cage to create a more natural look, such as branches, logs, pieces of bark and rocks. These need re-newing or cleaning from time to time to keep the cage hygenic. The choice is purely a personal one, as one branch may be a good shape to one keeper but not to another. All loose furnishings should be positioned so as not to hinder the keeper when servicing the cage and to offer the animal a feeling of security.

The use of live plants in a display should only be attempted if natural daylight is available, although this point is much argued amongst herpetologists. Plastic plants are a good substitute, they add colour and provide the viewer with a more natural looking scene, and they can also be removed for cleaning.

3 Heating is the most important factor if healthy and lively stock are to be maintained. There are numerous ways of heating a cage:

3a Heat pipes running along the front or rear of the cage; these can be electric, oil or steam. At the Cotswold Wildlife Park we use oil pipes along the front of the cages controlled by a thermostat at source.
3b Cables can be positioned below a substrate or above the animals in the cage. These have a disadvantage in that they can be exposed and the chances of accidental damage to the animal are increased.
3c Spotlamps can be used to heat a small cage from above, or as additional heat to create hotspots. If they are the only source of heat and light they cannot be used to the full effect because thermostatic control of temperature will leave the cage dark for periods of the day.
3d Heatpads can be used under a substrate or can be fixed on to a wall out of view in small cages.

It is best to have all heat elements well covered so that animals cannot come into contact with them and they cannot be seen.

4 Lighting is an important aspect of creating a cage environment. Fluorescent tubes are probably the best as they come in various lengths and sizes; they are best positioned out of public view.

Blacklight is used by some herpetologists for some species but is the subject of considerable debate.

Snakes do not require the use of blacklight at all, it is only various species of lizard that thrive from its use. A tube we use at the Park is the Philips Blacklight 09, this peaks between 290nm and 310nm which is the desired range for the species we exhibit.

Ultra-violet lights should never be used as these can be harmful to the animals. All lighting should be set on a cycle so as to create a photoperiod for the animals; the photoperiodic timing varies according to the species.

Correct timing of heat and light cycles can induce breeding in the captive animals.

Finally when displaying animals for the public some form on interpretation is necessary. At the Park we use formica labels giving the family name, where the animal comes from, the common name, the Latin name, its distribution range and its diet. We keep the information simple to create an interest in the animal on the part of the viewer. Further information can be obtained by asking a member of staff or using a reference library. We find that labels containing too much information have an off-putting effect and are not read or not fully understood by our visitors.

5

Sexing and Breeding Reptiles and Amphibians

Adam Wright, Herbert Art Gallery and Museum, Jordan Well, Coventry.

One of the more neglected areas of research in relation to live animal displays in museums is probably that of inducing captive livestock to breed. I believe that this should be a primary objective for the keepers of museum vivaria and many techniques are now available for inducing a mating response in display animals.

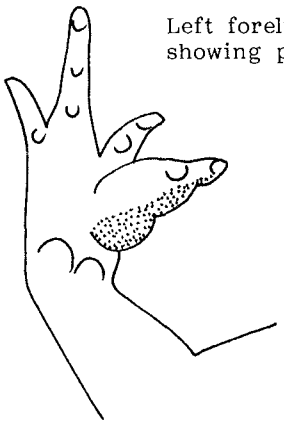
However, if breeding is to be encouraged both sexes must be present and, perhaps surprisingly, this can present problems for the keeper dealing with amphibians and reptiles. Whilst it is true that the males and females of some species are very difficult to distinguish, the majority of species can be sexed with a little care. This paper discusses the more commonly practised methods of sexing for these groups.

Anura - Frogs and Toads

One of the most easily discernible features of certain frog groups is the possession of inflatable vocal sacs which the males use to attract females - usually at night. When calling, the vocal sacs are filled with air and easy to see. On male specimens not in voice, the presence of a vocal sac can be determined by a folded wrinkly appearance to

the skin in the region of the sac. Females lack a vocal sac. Although not all male amphibians have vocal sacs, many Ranids, Rhacoporids, Bufonids and Hylids can be sexed in this manner.

During the breeding season the males of many Anuran species develop nuptial pads - the hardened growths on the forelimbs which are used by the male to grasp females during amplexus. Whilst these provide an easy means of sexing frogs in breeding condition, the nuptial pads are absent outside the breeding period. It is perhaps worth mentioning that Spadefoot toads (Pelobatidae) have horny growths on their hind feet to aid digging at all times of the year and in both sexes. These have no significance in terms of breeding function and in fact true Spadefoots (genus Pelobates) do not develop nuptial pads at all.



Left forelimb of male Anuran, showing position of nuptial pad.

The females of many frog and toad species grow significantly larger than males and generally appear more robust. This can, of course, be hard to quantify! Certain Anuran families can be sexed by means peculiar to that family, for example the Discoglossids (which include the commonly kept Bombina orientalis) can readily be sexed by forelimb shape. Male Discoglossids have much thicker front limbs than females.

Caudata - Newts and Salamanders

Doubtless we are all familiar with the sexual differences in breeding dress of our native newts - where the males become brightly coloured and develop body and/or tail crests. Such crests are also developed by many non-British species of newt but give little help in sexing specimens outside the breeding season; many species do not develop fancy display garb at all.

The most reliable method for sexing adult Caudata is to look at cloacal shape. In males the cloaca appears considerably swollen in comparison to that of a female.

Chelonia - Tortoises, Turtles and Terrapins

For most species of Chelonian, plastron shape gives a good guide to the sex of the individual. The plastron of males is normally concave, whilst that of females is flat or even convex. Unfortunately, this character is not readily seen in juveniles - nor, of course, is the fact that for many species females grow considerably larger than males (although this can be helpful in adults).

The tail of a male chelonian is normally longer than that of a similarly sized female of the same species, but the degree of difference varies greatly from one species to another. This fact provides an extremely easy method of sexing Testudo hermanni, Hermann's tortoise.

There is also a considerable difference in the tail length between the sexes in the Red-eared terrapin Pseudemys scripta elegans. However, these can be sexed even more easily by looking at the front claws on adult specimens. Males develop absurdly long claws which they use in courtship dance prior to mating.

Squamata: Lacertilia - Lizards

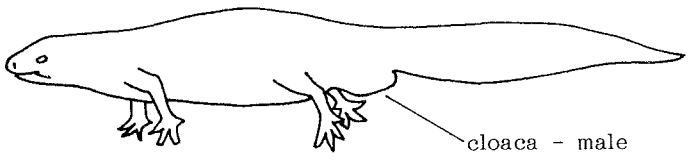
A large number of lizard species show quite marked sexual dimorphism. This may be in terms of colour (eg Sand lizards, Lacerta agilis), or physical adornment (eg the 'sails' on Basiliscus spp in males, or the bright throat-pouches in Anolis spp).

Needless to say many species are less cooperative and do not have sexually dimorphic colour patterns or specially adapted structures. Worse still, some lizards, particularly Agamids and Cordyliids, can cause further confusion through their ability to change colour. Thus the dominant male in a colony will display breeding male colouration, but other males in the group will adopt female colouration to show their submissiveness! Obviously care is needed in selecting 'pairs' on colour alone.

Reliable, constant characteristics are, however, exhibited by many species.

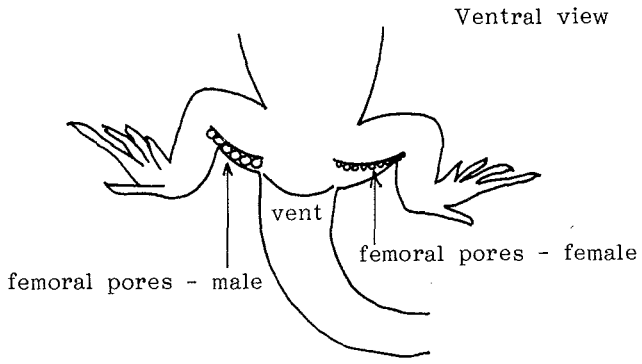
Secondary sexual characteristics such as the degree of enlargement of femoral pores can provide an easy means of sex determination in many Iguanids and others, including families such as Gerrhosauridae where sexing would otherwise be difficult. The femoral pores are much larger in males than females.

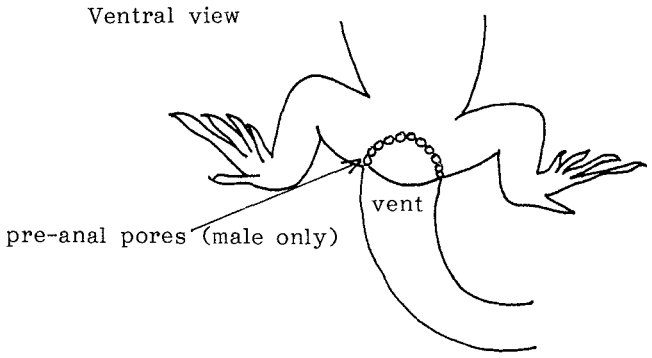
Another secondary sexual characteristic akin to femoral pore development is that of pre-anal pore development exhibited, for example, in Eublepharine Geckoes. Here the row of pre-anal pores is pronounced in males, but scarcely developed in females.



Because these pores are secondary sexual characters, the differences are unfortunately not discernable in juveniles.

Male lizards have a swelling at the base of the tail which is absent in females, but this is not always easy to see.





Squamata: Ophidia - Snakes

Perhaps because so few snakes show any sexually dimorphic colouration - the Adder, Vipera berus, is a notable exception - and lack (obviously!) femoral pores, they seem to cause most problems when it comes to sexing.

I have frequently heard claims that Boids can be sexed according to the length of their claws - the external remnants of their hind legs - but do not feel this method is at all reliable even though these claws are undoubtedly used only by males during the courtship rituals.

In virtually all species of snake the male has a tail of proportionately greater length than the female. In some species such as the Puff Adder Bitis arietans this makes snake sexing easy whilst in other species such as Blood Pythons Python curtus the method is useless.

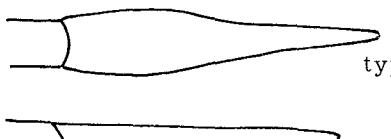
Happily, most Colubrids fall between these two extremes, and sexing by relative tail length is often possible. It is most easily accomplished by performing a subcaudal scale count. For any species, the number of subcaudal scales, although variable, will cover a set range. If, for example, this range is 50 - 80 subcaudals, then most snakes with a count of 50 - 60 subcaudals will be female, and those with a count of 70 - 80 are likely to be male. A subcaudal count in the middle of the range gives no real clue as to the sex of the specimen. Unfortunately, 'rogue' specimens with unusually short or long tails for their sex also occur, although fairly infrequently. Wright (1987) lists many known subcaudal ranges. If one is faced with a number of snakes for which one does not know the subcaudal count range, choosing the snakes with the highest and lowest subcaudal counts will normally produce a 'true pair'.

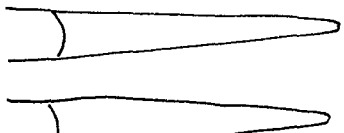
The tail also differs in shape between the sexes. This is because the male's hemipenes, when not is use, lie inverted in the base of the tail, facing the tail tip, causing a swelling immediately behind the vent. This swelling will be present in sub-adult and adult specimens, and provides an easy method of sexing for many species. Females lack this swelling in most instances. This difference is most obvious when looking at the underside of a snake, but a difference between males and females can also be noted in side view. The rapidity of tapering from vent to tail tip is much greater in female snakes than males, so a female's tail rapidly becomes thin behind the vent.

However, in certain genera, perhaps most infamously Lampropeltis, older females possess massive scent glands at the base of the tail, resulting in large swellings similar to those caused by male hemipenes. These also make interpretation of side view tapering difficult.

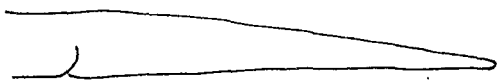
In such cases it is necessary to revert to subcaudal counts, or if available, probing.

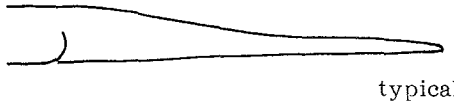
Ventral view





Side view





Snake probing is an extremely effective method of sexing snakes, but should only be undertaken by someone with considerable experience. By inserting a narrow, blunt rod at the vent, in the direction of tail tip, it is posible to determine the sex of the snake from the distance the probe can be inserted. In snakes of roughtly equal size the probe can be inserted considerably further in males than in females, since it travels down inside the inverted hemipenes.

Probing is not recommended for beginners, and the possibility of causing irreparable damage to small or hatchling snakes is considerable.

For sexing hatchling snakes (where probing is inadvisable), the subcaudal count method is useful. Bear in mind that this method can easily be performed on a cast skin, thus avoiding the possibility of stress to the hatchling.

Another method of sexing hatchling snakes relies on their nervousness, and is known as 'popping'. It is a certain, and apparently safe method, of snake sexing. Baby snakes can easily be encouraged to evert their cloacas, and in the case of male snakes this causes the paired hemipenes to 'pop' out. These are readily seen as a pair of dark red protruberances at each side of the vent. Many Lampropeltis and Elaphe hatchlings will evert their cloacas on handling; others can be encouraged to do so:

> Hold the snake ventral side uppermost; gently run your thumb along the base of the spine towards the tail tip. When you pass the cloaca and touch the base of the tail, gentle pressure combined with a reverse of direction is usually enough to get a snake to 'pop'. If the snake does not wish to comply, do not force the issue.

Eliciting a mating response

Reptiles and amphibians in the wild usually have set breeding seasons which are controlled by external climatic factors. These factors also trigger off mating responses in captive specimens. Thus by manipulating light/dark cycles in the vivarium to comply with those the animal experiences in the wild, together with appropriate changes in temperature throughout the seasons, one may induce a mating response. Certainly for many temperate species a cool winter resting period is a prerequisite for subsequent successful breeding. It is also advisable to separate the sexes at the time, reintroducing them in 'spring'.

Some amphibians from temperate areas can conveniently be placed in the fridge for a few weeks - this has been successful for Green Tree Frogs Hyla cinerea.

In the wild, Axolotls spawn in the coolest part of the year, and the addition of ice-cubes to the water in January or February will often induce spawning.

Mating responses in species from tropical areas, where day length is constant throughout the year, are triggered by other factors. For example Royal Pythons, Python regius, and Common Boas, Boa constrictor, both mate in December, a dry part of the year in their area of origin. Other species, however, appear to be stimulated by spraying lightly with water.

Care of eggs

In most amphibians, where fertilisation is external, the spawn can be collected, incubated and hatched in a short space of time. Pregnancy in reptiles, of course, follows a different pattern, and several weeks or even months will pass between copulation and egg deposition or birth of young.

As pregnancy progresses the shape of the reptile changes considerably as weight becomes distributed towards the posterior end of the animal. Many gravid snakes cease feeding.

For snakes it is possible to predict accurately the time of egg laying from the pre-laying slough. In the North American Columbrids, such as Elaphe or Lampropeltis, eggs are laid 10-12 days after shedding.

If a 5 litre ice-cream tub of moist sphagnum moss is offered to the snake about a week before laying, this will do much to reduce its nervous activity. Otherwise the snake will often rub its nose whilst hunting for a suitable egg-laying site. The container should be sealed, but have a hole cut in the side for access and egress. Failure to provide such a laying area can result in the eggs being laid in the water bowl and thus lost.

Although some snakes, eg Pythons, incubate their own eggs, I feel it is safer to remove eggs for artificial incubation.

I incubate all eggs in 'micafil' loft insulation material (vermiculite) and vary the humidity according to egg type. For 'soft' shelled eggs eg snakes, most lizards and aquatic chelonia, I recommend equal weights of water and micafil. For 'hard' shelled eggs such as land tortoises or some geckoes a lower humidity is required. I use a sealed container, and remove the lid each day in order to let fresh air circulate. It has been suggested that kyphosis is caused by oxygen deficiency, therefore if it is impractical to remove the lid regularly a container with air-holes in the lid should be used (although moisture-levels must then be checked regularly).

Ideally each egg should be separated from all others so that if one egg perishes and becomes mouldy it will not automatically infect the remaining eggs. However, snake eggs are covered in an adherent fluid when laid, and although I prefer to separate the eggs if possible, if a clutch is securely stuck together they can be successfully incubated 'en masse' although the risk of fungal spread increases.

Incubation temperature can fluctuate within the adult temperature tolerance range, although a constant temperature results in a more rapid hatching. Aim for a constant 28°C for most species - I would advise against temperatures over 30°C. Bear in mind that in some reptiles at least temperature dictates sex (particularly late in incubation period), therefore too high or too low a temperature may yield an imbalanced sex ratio in hatchlings.

After breaking the shell, the reptile remains in the egg whilst it absorbs the remains of the yolk sac. This period varies, but is normally longer in Chelonia than Squamata, and may be two or three days in the former.

Recommended reading

General works

Mattison, C. THE CARE OF REPTILES AND AMPHIBIANS IN CAPTIVITY. 1987 (1982). Blandford Press, Poole, Dorset.
Riches, R J. BREEDING SNAKES IN CAPTIVITY. 1976. Pet Reference Series, Palmetto Publishing Co, Florida.
Welch, K R G. HANDBOOK ON THE MAINTENANCE OF REPTILES IN CAPTIVITY. 1987. R E Kreiger Pub Co, Malabar, Florida
Zimmerman, E. BREEDING TERRARIUM ANIMALS'. 1986 (1983). T F H Publications, Ascot, Berks.

Specific aspects

Coote, J G and Riches, R J (1979). Captive Reproduction in North American Colubrids of the genera Lampropeltis and Elaphe. Proc. Cotswold Herpetological Symposium, 1978 pp6-15.
Thatcher, T (1987). Lizards in Confinement and their husbandry, parts 1 and 2. Monographs A S R A, 2 No 1 pp36-53.
Wright, A (1986) Notes on the captive breeding of the Florida Kingsnake, Lampropeltis getulus floridana, Blanchard, with observations on incubation of eggs and on the newly hatched young. J A S R A, 3 No 1 pp39-45
Wright, A (1987) Sexing snakes. Monographs A S R A, 2 No 1 pp2-10

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Paul Richards
Sheffield City Museum
0742 768588

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Edited by John Mathias, Leicestershire Museums Service, 96 New Walk, Leicester LE1 6TD (Tel: 0533 554100 ext.3030) to whom all contributions should be sent. Back numbers are available from the Editor.

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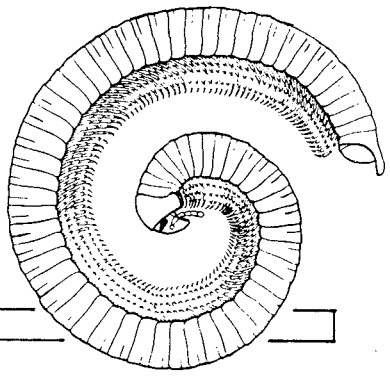

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