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Techniques in field studies of spiders

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Introduction

Over the past ten years we have studied the behaviour and ecology of spiders in a number of countries in various parts of the world. These studies have, in many cases, been carried out away from base (Smithsonian Tropical Research Institute) and away from laboratory facilities. For this reason we have had to develop a number of techniques and simple gadgets to facilitate our research. We feel that although these are not of great originality they may help other workers to save both time and money. Many of our studies have involved extensive travel and we have constantly faced the problem of streamlining our equipment needs to conform to the baggage allowance of international airlines.

Spider cages

Our studies have been entirely confined to web-building spiders of several families. Cheap cages for a wide variety of such spiders can be built out of cardboard boxes and light wooden framing. In most countries, even those with little industrial development, cardboard boxes (or cartons) tend to be manufactured locally and available in a wide range of sizes. We buy boxes of the appropriate size in quantity and flat (i.e. unassembled). Assembly is easy with a staple gun, or, if this is not available, with contact adhesive. Since we use cages to hold spiders for experiments on predatory or mating behaviour, or to obtain egg cocoons of known age and origins, access has to be easy and conditions right for web-building. A door of 2.5 x 2.5 cm framing can be made by simply butt-jointing the corners which are glued and then nailed. Using contact adhesive at the corners simplifies mass production. A large number of door frames can be fitted together and then nailed at the final stage of assembly. If the doors are measured to push-fit over the open end of the box (which is reinforced by having the four box-top folds pushed inside and glued) no door fastening is necessary. Since the door projects 2.5 cm beyond the floor of the box it is necessary to glue scraps of 2.5 x 2.5 cm framing to the outside of the base to level the box when it is standing on a table or shelf. The door frame is covered with some transparent material. We have used, in order of preference, clear cellulose acetate sheeting, mosquito netting (nylon and cotton), fibre-glass insect screening, flywire, horticultural grade polythene sheeting, transparent food-wrap plastic, etc. A number of dressmaking fabrics are tough and semi-transparent and can be used *in extremis;* we have even used nylon bridal veiling. The doors need not be accurately measured or squared since the box will give to the door's shape. Fig. 1 shows a cage built out of a 35 x 35 x 25 cm cardboard box in which the large *Argiope aemula* (New Guinea) lived and built full-scale webs.

We found that most spiders build webs most readily if they have top light. For this reason we always cut a window in the top edge of the box, using a carpenter's knife, and leave a sufficiently large cardboard border around this to attach some net covering. Net at this location allows the spider to be sprayed with water (see later) without the door having to be opened. The door and "roof" coverings can be attached with staples, drawing pins, glue or be taped on with a fabric backed adhesive tape. The latter provides the neatest finish (Fig. 1). Cages of this kind are durable and survive, even in tropical conditions, for several years if used indoors.

We have built large outdoor spider cages by using 2.5 x 2.5 cm framing and covering this with a large mosquito net. Some mosquito nets are built to fit over standard single beds and are in the form of a tent with square ends and three rectangular sides. These form ideal large cages that can be built to enclose vegetation; the wooden frame can be built to dimensions that allow the net to be slipped over the top, the net being cut only to form a tent-flap door. For long term work such cages are best fitted with a skirt of horticultural polythene, at ground level, to prevent damage to the net. Note that such outdoor cages are susceptible to invasion by rodents which will eat any accessible spider's egg cocoons.

Keeping small spiders in isolation can be best car-for live specimens and one for cameras and films. Using the cooler as a camera bag means that we need not worry about "cooking" the film inside the camera. Once one acquires the habit of returning film and cameras to the cooler immediately after use there is no problem of overheating exposed film. We find that when we are using a camera in the open for long periods, and have to leave it on the tripod during breaks in the action, we can protect it *in situ* by inverting the cooler over it like a tea cosy over a tea pot. (So many camera manufacturers make their products into heat sinks by painting them black or covering them in black leather. In difficult situations it is possible to partly rectify this design fault by covering the body of the camera with kitchen grade aluminium foil.)

Photography

Much of our work involves using at least three cameras for at least part of the time. We record behaviour units and sequences on movie film for subsequent analysis (frame-by-frame and slow motion) and also for use in preparing illustrations (see later). In addition to cinephotography we try to take black and white photographs of all the animals and events that need documenting photographically in scientific publications. We also like to have colour slides available for talks and lectures. The minimal travelling kit therefore consists of a movie camera and two still cameras. For safety's sake we actually carry two movie cameras on long trips since camera failure usually occurs when there are no repair facilities and replacement cameras can be extremely expensive in some developing countries. We have abandoned 16 mm work for Super 8 because of weight considerations and the fact that the omni-presence of tourists means that films and processing services for Super 8 are now almost ubiquitously available.

For close-up work with available light movies we find that a tripod is absolutely essential. In addition we use an extra-long rack and pinion focussing rail. This we regard as a necessity and not a luxury. Its use means that the tripod can be set down some distance from the vegetation to which a web is attached and the camera moved along the rail to focus it. Until we used the rail we had to move the tripod to get the camera at the right distance from the spider; this

Fig. 2: Movie camera with long rack and pinion focussing rail (authors can provide address of a U.S. supplier). The photograph incidentally shows the distracting effect of background complexity that can be obviated by use of a backcloth (see text).

almost invariably led to the web being shaken, the spider disturbed and the sequence delayed or disrupted. For this reason also we use a close-up lens on a wide range zoom lens. Movie cameras that have macro lenses focussing down to 5 cm from the spider are a liability not an advantage. At that distance the wind can easily blow the web into contact with the front element of the lens and the photographer is so close that he has to avoid breathing onto the spider while looking down the viewfinder. Fig. 2 shows the camera and long focussing rail in action.

A further gadget is an extremely useful addition to our equipment. This is a quick-release camera mount that attaches to the tripod or focussing rail. Such a device attaches to the tripod via the standard tripod screw and mates, at the touch of a button or a lever, with the male section that attaches to the camera tripod bush. The model we use has a lever to open the device for removing the camera, with it the camera can be removed from the tripod in an instant, and just as quickly replaced. This is not the case if the normal camera attachment screw of the tripod has to be slowly and laboriously unscrewed. If all the cameras likely to be used on a given tripod have the appropriate upper (male) section of the quick release device fitted to them they are instantly interchangeable. Time-consuming and annoying operations such as film replacement, battery changing and so on are greatly facilitated by this gadget.

Moisture is a constant hazard for most photographers in the tropics. Fungus grows on the lenses of cameras and can permanently etch the glass even if the mycelium is accessible for removal. Bearings in light meters corrode and stick under conditions of high humidity. We have found no real solution to the fungus problem except to have lenses cleaned professionally at the first signs. Storing equipment in a dehumidified room would be a long-term solution but this is seldom available; air-conditioned rooms are very much less likely to be moisture free but are preferable to normally ventilated rooms. A heated dry closet is far better than an open room but may get too hot for safe film storage, though cartridge loading cameras can be unloaded before being stored in heated closets. Placing damp cameras underneath light bulbs in hotel rooms is an emergency procedure that can work although light bulbs are inefficient heat sources. In the field movie cameras can sometimes be dried out if, mounted on the tripod, their film chamber is opened and pointed at the sun (with the film cartridge removed).

Two pieces of difficult-to-carry equipment are also useful and may, in many circumstances, be worth the effort involved. These are a windscreen and a backcloth. Wind is a particular problem for close-up photography where depth of field is always small. The web may move only 1 cm backwards and forwards but this may be enough to take the subject in and out of focus with annoying regularity. Spiders sitting on leaves may be similarly moved by wind. A frame covered in translucent polythene sheeting forms an admirable windscreen. Whenever we work at a permanent base we use several of these to surround a subject and cut down unwanted movements. Smaller collapsible versions can be built to fit on the roof rack of a car for transportation to more accessible field locations. Under natural conditions most spider activity takes place against a background of moving, complex, leaves and other plant shapes. These make a particularly distracting setting for macrophotography and we have found that it is usually possible to interpose a backcloth between the spider and the rest of confusing reality. A plain velvet cloth, clothes-pegs and drawing pins constitute the backcloth kit. The cloth is pegged or pinned onto suitable vegetation behind the subject. For colour photography blues and browns look well but black is probably the best for web photography. A wind screen can double as a backcloth if the frame is covered with an opaque matt-surfaced material.

Most of the time most field cinephotography will depend on available light. High speed Super 8 movie film is a great help when filming in the dim light of tropical forests but it is so grainy that it is impossible to see fine detail in extreme close-ups. In situations where it is barely possible to get an exposure at the camera's maximum aperture it is often possible to enhance the picture by reflecting sunlight onto the subject. Such additional light may not affect the reading on the camera's light meter but will show up details that are otherwise in shadow. We have converted a circular shaving mirror for this purpose by simply soldering a suitable nut to its stand. The nut fits a standard tripod screw and enables the mirror to be placed in a good light-reflecting position without being held. An emergency reflector can be made out of aluminium foil.

There have been innumerable articles in photographic magazines on the subject of close-up 35 mm photography. Most of these ignore the problems likely to be encountered by a travelling researcher who uses photography as a tool. We have found that it is impossible to carry more than one tripod and therefore rely on hand-held equipment for still photography. This means that all photographs are taken with electronic flash. The set-up must be effective, portable, reliable and easy to operate. We have found that the best system is to keep to one film for black and white work and another for colour, and in both cases we use a slow fine-grained emulsion. Having decided on a film we work out an arrangement of electronic flash equipment that allows us to take all the shots that we could conceivably need using one or two fixed f stops. Thus we both use different makes

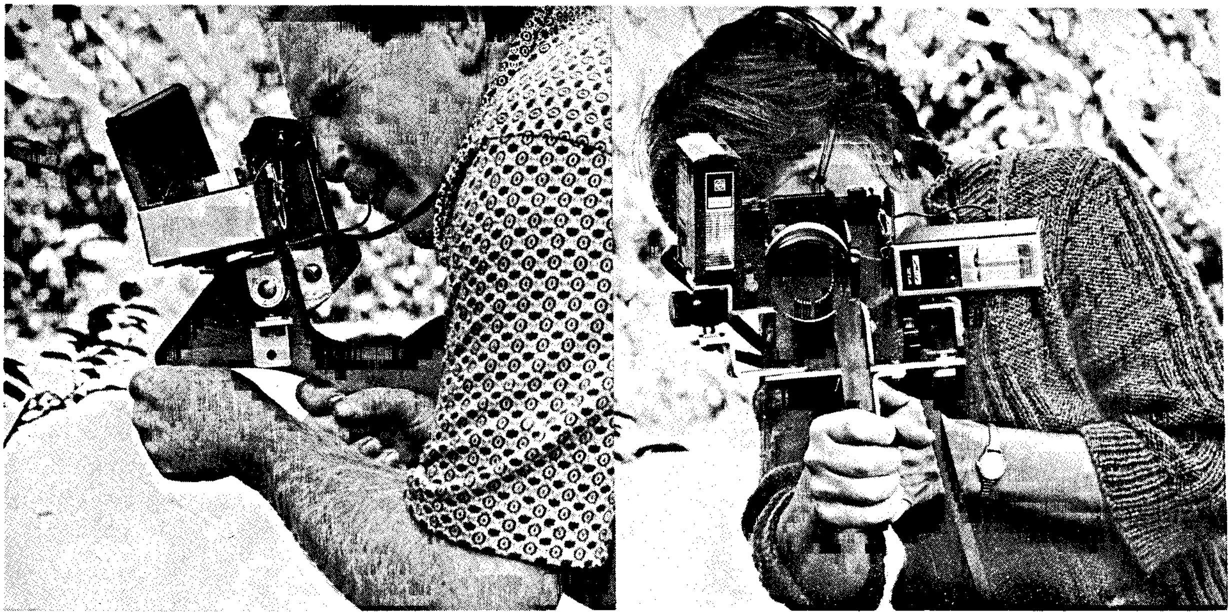

Fig. 3: Home built gunstock mount with twin flash arrangement for macrophotography. Left picture shows how the twin grip can ensure steadiness (camera is fired by using a cable release on the foregrip). Right picture shows details of the flashgun mounts. These are small inexpensive ball and socket "bounce flash attachments" that normally fit into the accessory shoe of a camera. They are highly adjustable and can be moved up/down or left/right at the turn of the knurled knob.

of cameras, lenses, and flashes but shoot at f16 or f22 and a constant (flash synchrony) shutter speed. It is thus a matter of aim, focus and shoot with no computation, calculation or fiddling with camera controls. The arrangement of the flash equipment is important and close-ups taken with unidirectional illumination have deep distracting shadows. The solution to this problem is the use of a ring flash or two flashguns. One of us (M.H.R.) uses a ringflash. It is perfectly satisfactory but is no better than two cheap flashguns mounted to illuminate the subject from each side, with their area of illumination overlapping on the subject. The arrangement of two flashes depends on the lens used but we have built several devices that allow us to attach the two units to the camera with their fronts level with the extended macro-lens and the angle adjustable relative to the film plane. Custom-built devices that do just this can be bought but it is a challenge to build a do-it-yourself gadget. Fig. 3 shows a home-made gunstock mount for close-up photography which has highly adjustable flash mounts for consistently good close-up results. The gunstock ensures a steady camera hold and though normally used for telephoto work is an excellent aid to macrophotography.

Electronic flashes designed to work off penlight batteries seem to be in every way superior to the more expensive rechargeable units. The batteries are available in the most out of the way places where there may be no source of current for charging nickel-cadmium cells.

Drawings from films and transparencies

Although it is hardly a field technique we find that films and colour slides make good bases for the preparation of really accurate drawings of postures or behaviour units. The exact attitude of an animal can be traced off a projected image and the details of morphology checked against a specimen. For this purpose it is extremely useful to project the image onto a horizontal surface. This is easily arranged by clamping a mirror into a laboratory retort stand and placing this in the beam from the projector. The angle of the mirror can be adjusted and the position relative to the projector, and drawing board, can be used to obtain the correct image size.

Finding spiders

Brief visits to strange countries leave little time for adequate exploration but there are certain areas that can be visited to check whether the spider fauna is likely to merit further effort. In capital cities, and elsewhere, botanic gardens are among the best places to sample. They usually have a large number of different habitat types, a long-established rich flora, and have all this in a condensed area. Furthermore most botanic gardens have areas that are irrigated during the dry season and these may yield spiders that are not present elsewhere. Municipal parks are usually almost as good as botanic gardens and zoos often have a fauna of spiders as rich as the fauna in cages. Night collecting is always exciting and often productive; an enclosed botanic garden or park is a good place to work if the Director can be persuaded to give permission. Last but not least areas of vegetation that are floodlit at night are always worth looking at and this applies to the flower beds at the international airport.

ried out in plastic vials. Males in particular survive for long periods as long as they are given water to drink. We use a cork borer to make holes in the plastic snap-caps of vials and insert a small wick of cotton wool. This wick can be carefully wetted on the outside and water will then become available to the spider inside. Care is needed to prevent overwetting since small spiders have surface tension problems and easily become trapped in globules of water. A collection of live spiders in vials is most easily serviced, fed and watered, if it is stored in a rack of some kind. Racks can be improvised from flat boards and flat elastic. The elastic is simply pinned or stapled onto the board to form a bandolier. The vials can then be stored flat or upright; we find that storing them flat prevents araneids from attaching their webs to the cap and they can then be fed without too much disturbance.

A water spray (from garden shop or hairdressers) is a useful accessory for spider keeping and can be used to spray water onto the web surface to allow large spiders to drink.

Carrying spiders and equipment in the field

Working in the tropics presents problems when carrying live spiders (or delicate camera and electronic equipment) for long periods in vehicles or in bright sunlight. Excessive heating is likely to occur and produce disastrous results. The plastic beer cooler is a perfect answer to these problems. Essentially this is an insulated container made of expanded polystyrene and equipped with carrying handles, or, best of all, a shoulder strap. If a beer cooler is not available a school satchel or camera bag can be lined with styrofoam acoustic tiles (or sheeting) glued together with plastic model cement. Vials carried in an insulated container are safe even when the bag is left in sunlight. We usually carry at least two coolers, one

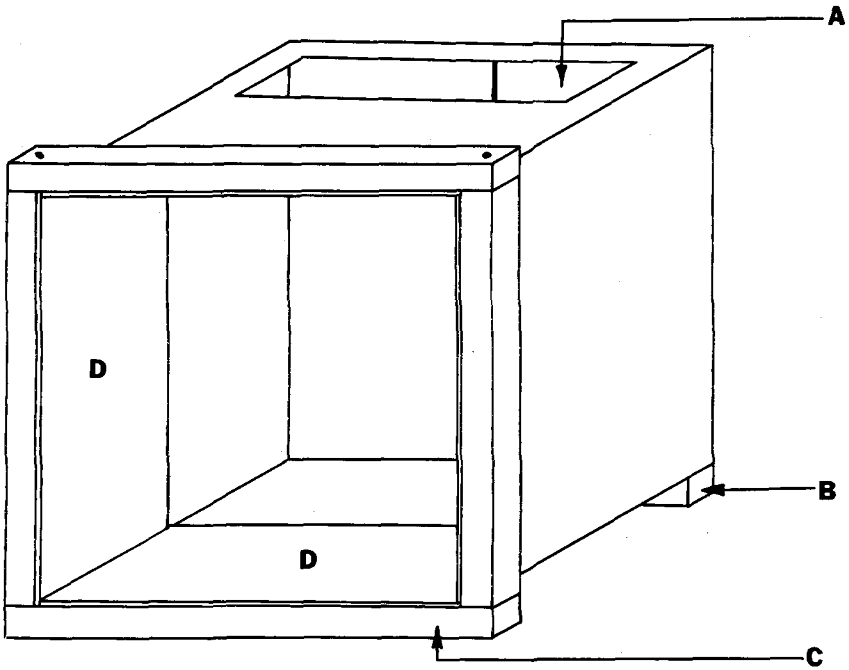

Fig. 1: Isometric view of spider cage. **A** is opening cut in top of cage to admit dorsal light; in the finished cage this is covered by screening or transparent plastic. **B** is 2.5 x 2.5 cm foot added to cage base to level it. **C** is door frame made of 2.5 x 2.5 cm wood, butt jointed, glued and nailed at the corners. The door is a push fit over the open end of the box. **D** the flaps that formed the original top of the cardboard box are turned in to reinforce the opening. They can be stapled in place but the cage is greatly strengthened if these and the bottom flaps (now the opposite side to the open one) are fastened in place with contact adhesive.