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THE CULTURE AND COLLECTION

OF LIVEFOOD FOR

AVIARY, AQUARIUM AND

VIVARIUM

DAVE COLES

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INTRODUCTION

The need to provide an adequate and varied supply of livefood for the smaller insectivorous and omnivorous animals kept by hobbyists has long been a problem. In recent times, a number of different types of invertebrates have become available through commercial outlets, a far cry from only a few years ago when available forms consisted solely of fruit flies, mealworms, locusts, whiteworms and blowfly larvae (maggots). Efforts made by the amateur at culturing the various forms are, for the most part, very much a "hit and miss" affair because of a scarcity of literature covering the subject. As with all forms of stock, correct management pays dividends. With this in mind, these notes have been compiled both from personal experience and with the use of available literature covering proven techniques in the hope that some of the problems associated with the culturing of livefood by the amateur can be satisfactorily overcome.

It is unlikely that the scale of home production will supply all the livefood needs of anything but the smallest collection, but it is, none-the-less invaluable for supplementing commercial supplies, for providing a greater variety or as a temporary safeguard should commercial supplies of livefood be disrupted by unforeseen circumstances.

For convenience, the text commences with sections covering a variety of subjects applicable to culturing, purchasing and collecting of livefood and concludes with an alphabetical coverage of a number of species and groups together with their respective cultural requirements and collection procedures.

The first edition of this book has been out of print for some time and because of the interest shown recently it has been decided to revise and expand on the original to take into account some of the lesser known livefoods. These are used in feeding some of the more specialised groups of animals, in particular small reptiles and amphibians. More vertebrates have been included in this edition.

There has also been an upsurge in livefood-related equipment available over the last couple of years and these items have been included, either in the Directory of Equipment and Foods or under the relevant species if deemed of use.

Future information on livefood, as it becomes available, will be made available through my website, along with details and updates of my other publications. For those without access to the Internet, details can be obtained by sending a fifty pence stamp to the address below.

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COLLECTING LIVEFOOD FROM THE WILD

The true value of collecting from the wild depends on the amount of time one is able to devote to it, for generally it is, a very time consuming business. However, with certain species of birds, reptiles and amphibians the need to provide a particular form of livefood, especially where newly hatched young are concerned, makes it a chore that has to be done if success is to be achieved. Purchased livefood is convenient, but if a species has young and are proving difficult to rear on commercial livefood, then collecting from the wild will usually provide the answer.

A wide array of creatures can be caught if searched for in the correct locality. Pit-fall traps (shallow containers sunk in the ground) have only a limited use for, quite quickly, predators get to know the receptacles and thus are provided with an easy meal! When collecting, one must constantly be aware of the need for conservation and so, for this reason, moth traps should be avoided, other than for use on farmland and in gardens where research has shown little effect on populations if used in moderation. Indiscriminate use of moth traps can do untold damage unless one is expert in the identification of nocturnal Lepidoptera; and can, thereby, release rare species from the trap.

The general rule for collecting is to restrict it to areas where one or more common plant species occur abundantly. Invertebrates tend to be host specific in their requirements, either for each stage of development or its entirety. It is therefore less likely to cause decimation of a fragile population if collecting is restricted to areas dominated by nettles or ivy, as it would, say, in a mixed woodland where a tree species may be represented by only a single specimen, which, although it may not be a rare species, may represent a habitat for nationally common, but locally rare species. Gardens are a particularly good place in which to collect livefood.

A net is by far the best way to gather livefood. This can be purchased or home-made using a nylon stocking stitched on a loop of wire connected to a handle. The latter is preferable as nets are subject to considerable wear and need replacing frequently. On a fine day all that has to be done is to find a patch of nettles or long grass and sweep the net through. On wet days, however, the catch will be less than satisfactory. Once caught the contents can then be placed in a large jar for transporting.

Another method sometimes used is beating. This involves placing a sheet under a tree and beating it with a stout stick. However, while this yields a certain amount of livefood, the use of a net is preferable if you have a choice. When collecting, a site that is known to be free from contamination must be used, uncertainty can lead to loss of stock through poisoning. More specific notes on collecting are given under individual species accounts.

On a final note, legislation in some countries prohibits the taking of certain species, and by specified means. If in doubt, always check with the appropriate authorities. The author cannot accept responsibility for the contravention of any such regulations.

PURCHASING LIVEFOOD

Although this publication relates to the culture of nearly fifty types of livefood, it is by no means exhaustive in its coverage. Others are available through suppliers and are usually purchased in quantities that will be consumed in a relatively short space of time. When ordering, ask for culture or maintenance notes, which will help maintain that particular type of livefood for a short time. Many suppliers give basic information with each purchase, some do not. For species covered in the main text, the sections on housing and feeding will provide the information needed to maintain them over a short period. Remember, however, that these notes relate to breeding stock and that large numbers of livefood held in small containers will soon perish. If livefood arrives in poor condition, complain; if consistently poor, change suppliers.

A wide selection of livefoods can be purchased frozen (see below). While these are meant largely for the use of aquarists, there is no reason why experimental feeding to other animals cannot be tried. One aviculturist successfully induced several species of waxbills to take thawed Gamma Shrimps

when rearing young. Current lists of available forms of livefood and prices can be obtained through advertisements in hobby publications such as Cage and Aviary Birds, Bird Keeper and The Aquarist.

The author has found Livefood Direct, Rob Harvey Specialist Foods and Peregrine Livefoods all provide reliable and good quality livefoods and their addresses are given below.

FROZEN LIVEFOOD

The range of frozen livefood available to the hobbyist these days has increased quite considerably to what it was even a comparatively short time ago. Fish are perhaps the best catered for but most types of livefood can be offered to other species that take food from water.

From the larger, more specialised aquarists shops, Brine Shrimp, bloodworms, *Tubifex*, *Daphnia*, *Cyclops*, Krill, Red Plankton, *Mysis* shrimps and the larvae of both the Black and White Mosquitoes, amongst others, can be purchased. Non-specialised pet shops will generally, supply only Brine Shrimps, *Daphnia* and *Tubifex*. A glance through Yellow Pages or through a copy of one of the fish-keeping magazines will usually be sufficient to find a stockist.

A wider range is now bred and available frozen for the larger carnivores. Day old chickens and turkeys, rats and mice (in various growth stages), rabbits, guinea pigs, Japanese Quails and various fish can be easily obtained. Perusal of classified advertisements in the previously mentioned specialist publications covering animal keeping will provide sources, as will outlets specialising in reptiles, amphibians, birds and fish. Buffalo Worms, Mealworms, Waxworms and Pinkie Maggots can also be purchased frozen.

DRIED LIVEFOOD

Dried shrimps and various insects, mostly the several stages of mealworm, are frequent constituents of many of the commercial softfoods. Mealworm production during low demand periods is not much reduced and these provide much of the insect content of these foods. Various other dried foods are available and perhaps Livefood Direct offers the best selection with ant pupae, Conchos shells, *Daphnia*, mini prawns and a mixture of larvae. They can be mixed with normal food or fed separately.

DIRECTORY OF EQUIPMENT AND FOODS

This section is intended to provide an indication as to where certain items mentioned in the text may be obtained. Most are self-explanatory while the less frequently encountered can be difficult to locate. See next section covering useful addresses.

Agar: May be found in health food shops or purchased direct from biological suppliers such as Philip Harris Education.

Aquariums: Although the cost can be high, these tanks are the ideal accommodation for a number of species. The moulded plastic types, obtainable through pet shops, are the most practical because of their lightness and durability and work out much cheaper than glass ones, although larger sizes can be had in glass. Personal preferences, space and cost are deciding factors as to which type to use.

Drawing Pins: Obtainable from most newsagents and office suppliers. Those with easy grip heads are best if used as a frequent fastening source and are variously termed mapping pins, push pins or poster pins.

Electric Hen: A heating pad on legs such that chicks can get underneath for heat. Have the advantage of not needing a heat-lamp to provide a heat source, thus reducing the risk of feather plucking when rearing species such as Galliformes.

Flour: Generally, wholemeal flour is used and this is available from supermarkets and health food shops.

Gauze: Available in both metal and plastic. Ideal for providing ventilation in containers. Available through Philip Harris Education; also larger hardware and DIY outlets. Copper is satisfactory if used in areas of high humidity, although plastic may be used if unlikely to be chewed. Stainless steel is superior for all applications but is highly priced.

Heating Pads: Can be useful in providing bottom heat for certain cultures. Obtainable through biological suppliers or outlets supplying the needs for home wine-making. Better than light bulbs for they do not provide illumination.

Incubators: Prices vary considerably. Obtain a copy of Cage and Aviary Birds from a newsagent and contact suppliers listed. Think carefully before purchasing**.** A competent DIY enthusiast should have little difficulty in creating one from components but care must always be taken with electricity.

Misters: Spray-misters, intended for use with house plants, are available from many outlets, not only garden centres but supermarkets and most hardware stores. Useful for increasing humidity and for damping down to help minimise dust during cleaning.

Muslin: Small quantities may be obtained through health food shops while larger quantities can be purchased from some clothing material retailers and biological suppliers.

Netting: Various types are available. The smallest meshed netting, in black, is the easiest to work with. Available from entomological and biological suppliers.

Nipple Drinking Systems: Can be useful for mammal species. Obtainable from Southern Aviaries Ltd.

Perforated Zinc: Larger hardware stores should be able to obtain it, even if not held in stock.

Plant Propagators: Available from garden centres and department stores. Because of difficult access they are of limited use other than for housing snails.

Rainwater Storage Tubs: The standard black plastic dustbin is available from hardware stores and can be adapted. They are cheap to buy and a tap can be fitted if needed.

Rubber Bands: Thick parcel bands are recommended, but if heavy duty "inner tent" bands can be purchased from camping stores or sites, so much the better as these are virtually indestructible.

Storage Jars: Available in both plastic and glass from a number of outlets. Reject shops are a good source of reasonably priced glass jars but care must be taken when cleaning them - very hot water should be avoided as the glass usually has a weak spot. Smaller types, such as coffee and jam jars, are of little use other than for temporary housing.

Sweet Jars: A most useful container for a good many species and the larger a stock kept of them the better. Local sweetshops should be able to supply you with a number of 7 lb sweet jars for a small charge. Most are now plastic but glass ones may still be found.

Velcro: Obtainable from larger newsagents, office suppliers and haberdashers.

Water Bottle: A useful home-made device for providing water over a long period of absence. Any bottle with a screw top will suffice. Pierce a hole in the screw top and insert a piece of absorbent cloth or blotting paper through it making sure it is long enough to touch the bottom of the bottle. Leave only a short length protruding from the cap for the insects to extract moisture. When filled with water this method should last for several days but should be checked as often as possible, especially with species such as crickets that are likely to chew the cloth or paper.

Livefood Direct has brought several alternatives to the fore. They now produce a water bottle with a foam donut, which if space permits, is ideal. They also produce granules to which water is added and is a useful alternative to water. Best value is to purchase the granules separately and find a screw-capped jar that holds a litre of liquid.

Yeast: Dried, inactive yeast is available from chemists and supermarkets. Do not use active yeast!

USEFUL ADDRESSES

Barratines Environmental Health St. Ivel Way, Warmley, Bristol BS30 8TY. Tel. 0117 9672222. **www.barrettine.co.uk/Environmental-Health/**

International Zoo Veterinary Group Keighley Buisness Centre, South Street, Keighley, West Yorkshire. Tel. 01535 692000 www.izvg.co.uk/ .

John E. Haith Park Street, Cleethorpes, Lincs. DN35 7NF. Tel. 01472 357515. www.haiths.com/(Seed).

Livefood Direct Unit 1, Universal Crescent, North Anston Trading Centre, Sheffield S31 7JJ. Tel. 01909 568953. www.livefoodsdirect.co.uk/ (Bulk supplies of livefood, commercial diets and extensive range of equipment).

Livefoods UK The Acres Gills Lane Rooks Bridge Somerset BS26 2TZ Tel. 01934 750743 www.livefoods.co.uk/ (Bulk supplies and equipment)

Peregrine Livefoods P.O. Box 45, Loughton, Essex IG10 2NF. Tel. 01992 815605. (Bulk supplies and starter kits). www.peregrine-livefoods.co.uk/

Priors Pets Cottage Nursery Howards Lane Cardinals Green nr Horse Heath Cambridgeshire CB21 4QX Tel 01223 892500 www.priorspets.co.uk/ (Bulk supplies and equipment)

Philip Harris Education Novara House, Excelsior Road, Ashby Park, Ashby-de-la-Zouch, Leicestershire LE65 1NG. Tel. 0870 6000193. www.philipharris.co.uk/ (Equipment).

Rob Harvey Specialist Foods Kookaburra House, Gravel Hill Road, Holt Pound, Farnham, Surrey GU10 4LG. Tel. 01420 23986. www.robharvey.com/ (Bird requisite specialist).

Top Insect Paanderstraat 75 8760 Meulebeke Belgium Tel +32(0)51/487253 www.topinsect.com (Frozen Insects)

Watkins and Doncaster P.O. Box 5, Cranbrook, Kent TN18 5EZ. Tel. 01580 753133. www.watdon.co.uk/ (Equipment).

Waggler Worms Brook Farm Loscoe Derbyshire DE75 7LG Tel 07773 760082 www.wagglerworms.co.uk

Worldwide Butterflies Ltd. Compton House, Sherbourne, Dorset DT9 4QN. Tel. 01935 74608. (Equipment and breeding stock). www.wwb.co.uk/

CLEANING EQUIPMENT

As with all stock, hygiene is of the utmost importance. This is especially so with invertebrates as, quite often, cultures can develop into large populations in cramped conditions that are both warm and humid - an ideal recipe for promoting disease if cleanliness is not maintained! All equipment should be thoroughly cleaned when the opportunity presents itself, using a high quality detergent-disinfectant. Several such preparations are manufactured specifically for laboratories and, although relatively expensive, are excellent. A household disinfectant will suffice if small quantities of equipment need to be cleaned. Microwave ovens are also very useful for sterilising small items made of a material approved for use in such machines. Check manufacturer recommendations carefully.

PLANT PROPAGATION

Within these culture notes, reference is made to the propagation of plants as food for certain species of livefood. All are common, easy to grow forms, and although brief details are given a more thorough account will be found in most gardening books. One essential point to remember is that any plant used as food is bound to take quite a beating so it is advisable to have a number on the go at once, with some retained in reserve for emergencies and as stock plants.

CULTURE REQUIREMENTS

ANTS

Very few species actually eat adult ants but the nutritious pupal stage, commonly known as "ant eggs" is taken avidly by a range of creatures. Culturing is a relatively straight forward matter but, because of the vast number of pupae that can be eaten by a comparatively small number of individuals, culturing large scale, to satisfy all your needs, is not a practical proposition. Breeders wishing to experiment with an artificial chamber for those ant species which live below ground, and for a nest to accommodate Britain's largest species, the red and black Wood Ant *Formica rufa*, whose large nest mounds are often found in pine woods are advised to consult Coomber and Hogg. It is from the Wood Ant that commercially available pupae are obtained, mainly through importations from Eastern Europe.

Collecting Pupae: To all intents and purposes the collection of fresh pupae is the most favoured option and can be easily achieved. The Red *Myrmica rufa*, Black *Lasius niger* and Yellow Ants *L. flavius* are all common species about the garden, building their colonies under stones, rotting wood or at the base of walls. In these species, pupae are visible once the object under which the colony exists is removed. Early

afternoon on a warm day when pupae are brought close to the surface is the most productive time to search.

As colonies which nest in close proximity to human habitation are often of nuisance value, the whole nest can be removed. Using a trowel dig out the whole nest, or part as required, and place in a bucket or directly onto a sheet. Low, dark areas must be provided so the ants can transport their pupae to a safe place. This is best done by turning over the corners of the sheet which can then be periodically lifted and the accumulated pupae collected. This method can also be adopted for the Wood Ant but a much larger sheet is required, and a spade, rather than a trowel, should be used. It is possible, when using this species, a surplus of pupae may arise, in which case they can be frozen for later use. Caution must be exercised however, as this species not only bites but is capable of squirting formic acid in defence. This is an irritant, especially if contact is made with eyes or broken skin, and should be washed off immediately.

Collecting Adults: Few species will eat adult ants but if keeping a species that will, the best method of collecting is simply to place slices of apple, orange, or for that matter, any variety of sweet fruit near an active nest. After a short while, simply pick up the fruit and its passengers and drop it into a sealable container. Feed to stock as soon as possible after capture. Cloth moistened with sugar solution or honey water will also attract adults. Ants will survive for a short while but trying to keep them for any length of time is not recommended.

APHIDS

Aphids are abundant in the warmer months of the year and many species can to be found in Britain. Most are host specific, completing their complex breeding cycle on just one type of plant. Several, however, use more than one and, in such cases, each plant is an essential requirement for a particular period in an aphids' development. The summer host is usually the most productive in terms of harvestable insects and it is these that should be encouraged or planted if aphids are to be utilised as livefood.

Collecting: Although aphids are taken by only a limited number of species because of their small size, their collection is worthwhile in order to add variation to an otherwise restricted diet. Species that will take aphids tend to be small insectivores and as such they can form quite a substantial part of the diet of some reptiles and amphibians. The types most likely to be encountered are the Black Bean Aphid *Aphis fabae*, a species able to live on a number of plants, including elder, nasturtium and most varieties of cultivated bean plants, and also, the "greenflies" which infest roses and nettles.

Collecting is easily done by removing the infested section of the plant, if practical to do so, or by removing the aphids with a fine paint brush. If small numbers are required periodically, the colony can be left intact and a number removed as and when needed. If a heavily infested plant is located, surplus aphids can be frozen. This is best done by placing cut pieces of the plant, complete with aphids, onto a tray in the freezer and, once frozen, usually in a very short time, a light tap will be enough to dislodge them and they can then be placed in sealed containers for later use. Following this method ensures that individuals remain separated and do not form a solid, sticky mass.

Encouraging the Black Bean Aphid is simply a matter of growing broad or runner beans in pots - before long and with conducive weather conditions, aphids should soon colonise the plants and multiply rapidly. If they do not, look on the bright side, you should have a good crop of beans!

Life Cycle: Aphids have a breeding system ideally suited to mass production. Over-wintering eggs hatch to produce wingless, parthenogenic females which, once mature, give birth to live young. These, in turn, do likewise leading to many generations being produced in a short space of time. Some winged females are produced by each generation and these fly off to start new colonies, hence the sudden appearance of aphids in areas that only days before were clear of them. As autumn approaches, some males are produced and mating takes place to provide the eggs needed for over-wintering. This is a much

simplified explanation of what, in reality, is a very complex breeding cycle. Suffice to say, if properly managed, aphids can produce an abundant source of livefood for the species that will take them.

BEES

The culture of Honey Bees *Aphis mellifera* is beyond the scope of this booklet as the equipment needed to set up is relatively expensive and unlikely to be attempted by anyone requiring only a few for species which will take them. If however, you were contemplating keeping a number of bird species that will eat them, i.e. rollers, bee-eaters, shrikes etc. the setting up of several hives in the vicinity, if locality allows it, would be most beneficial. If this is the case, professional help should be sort in establishing hives and to secure the basic training needed to work with these creatures. A look through Yellow Pages will help, as would contacting established apiarists.

If only a few are needed, an attractant in the form of flowering plants can be considered. Lavender and buddleia are perhaps the best two garden plants to use and both can be purchased quite cheaply from garden centres. In mild winters, mahonia is frequently used as a source of nectar.

BEETLES

The order *Coleoptera* contains more species than any other insect order. Beetles are found in practically every part of the world, frequently coming into contact with humans and their lifestyle. This close association has resulted in a never-ending battle against pest species that attack cereal crops, building materials and household furnishings. The main weapons against these intruders are the insecticides, which have been developed in research institutes throughout the world and tested on the insects concerned.

To provide the data needed for conclusions, insects are required in considerable numbers and because of this, culture requirements have been developed for many species. In the British Isles alone, there are in the region of 110 species in culture. Such intensive culturing has been responsible for perfecting rearing techniques for many species, not least the humble mealworm which has been bred as a livefood for many years, but which is still a pest of stored cereal crops in many parts of the world. Because of the pest aspect of many *Coleoptera*, very few are safe for the amateur to propagate and, for this reason, only a limited number are discussed here. None-the-less, the five species covered will provide a size range of larvae, the most beneficial of development stages, that will be taken by even the smallest of creatures.

As a general rule, temperatures of around 25 °C with a relative high humidity of 70% are required for culturing, but a good success rate can be achieved by simply keeping them warm. To a certain degree they can themselves regulate conditions within the culture so far as humidity is concerned, provided there is not too much moisture present in the first instance. In this event, mould will form and create various problems including disease and mites. If mites do show in a culture, destroy it and thoroughly clean equipment before starting afresh. Don't be tempted to isolate any development stage from an infested culture to start a new one - mites are small, eggs even smaller.

Try leaving some larvae of all species to mature into beetles and see if they will be eaten. If so, they will provide an additional, valuable source of livefood and one that is rarely offered.

MEALWORMS *Tenebrio molitor*

As the mealworm, a flour beetle, is readily available commercially, it is debatable whether or not resources could not be better utilised for another species of beetle which is far less demanding of time and space. Over the years opinion has been divided as to their true value as a livefood because of digestive problems caused by excessive use. Given in sensible quantities, and varied with other forms of livefood there can be little doubt of their value, especially to newly imported stock as an aid to getting them established.

Fat	12.7%
Protein	20.3%
Calcium	133ppm
Phosphorus	3345ppm
Ca/P Ratio	0.04

Occasionally, what seem to be white specimens will appear in a culture. These are developing larvae that have recently shed their skin in the growing process and will darken as their new skin hardens. Interestingly, these "whites" are taken by some species that will not touch those with the darker, hardened skins and are also the preferred form to offer newly emerged young stock. The dark-skinned forms can be chopped up before feeding to young but this is far from ideal as it often ends up as a sticky mess.

Obtaining Stock: By purchasing larvae from a supplier, either direct or by post, and growing on to the adult beetle stage at which point home culturing can begin. Most livefood suppliers will only supply the larval stage but adult beetles may be available from biological suppliers if the initial setting up needs to be hurried. Purchasing mealworms from a breeder (see list of suppliers) can work out much cheaper, if quantities of at least 500 g are bought, than if buying from a pet shop, where 50 g may cost £2. Taking it a step further, if the conditions and receptacles are available (see next paragraph), the purchase of 2 kg is a perfectly feasible option for heavy users, making the comparative price drop quite considerably.

Housing: If only a few are needed for feeding, a culture can be developed in a large container constructed of plastic, wood or metal with a tight fitting lid of wire gauze on a frame. However, a culture where all stages of development are present is, perhaps, the least productive, for adults, even when properly fed, tend to be cannibalistic toward eggs and young larvae. Newly formed pupae are particularly vulnerable. Jars of various sizes and smooth-sided plastic trays, which are at least 75 cm deep, are ideal if periodically new cultures are to be set up.

Purchased mealworms, used solely for the purpose of feeding to stock can be kept in trays, buckets or dustbins for quite some time if provided with bran or bread and moisture in the form of slices of apple, carrot or a damp piece of cloth. For longer periods, Livefood Direct's "Solid Water" is ideal, especially if the culture is being left for any length of time. However, offer it at least three days in advance if relying on it while away to give the mealworms a chance to become accustomed to it.

Commercial diets are also available which are produced to be rich in protein, have a high calcium to phosphorus ratio and contain added vitamin D3 to aid calcium uptake. Mealworms, and for that matter most other livefoods, if forming the sole means of nutrition for young, can lead to a deficiency if the right balance of these important elements is lacking. If continued trouble occurs with bone problems and soft-shelled eggs, and no account is taken of this imbalance, it should be the first line taken in trying to rectify the condition. Sole reliance on only one form of livefood however, is asking for trouble.

While these diets are beneficial, mealworms in particular, consume large amounts of food and this will add to the overall cost of livefood. If this is an important consideration, feed as recommended for storage and remove enough mealworms for the following days feed and place into a separate container with a small amount of the commercial diet. Costs will be reduced and the diet benefit will include gut-loaded nutrients. Unfortunately, most such foods are produced in meal or pellet form that leave a residue of dust which is likely to contain nutrients which are not taken up. There are plans to produce a gel, which would be much better.

If the container allows it, crumpled newspaper can be given as this provides extra climbing space. Keeping larvae cool, between 10-12 °C, will slow development without too much effect and this may allow for the purchase of extra quantities as the larger the quantity purchased, proportionally the cheaper they become. Some may turn into pupae but these should still be eaten as indeed will the beetles by some species. Mealworm development can be slowed for several months in the summer using this cooling method and for up to four months in winter.

Culturing Procedure: Vessels used for culturing should first be thoroughly cleaned. Into them place the cereal content of the diet which can consist of a variety of foods. The Slough Laboratory diet consists of wheatfeed, rolled oats and dried yeast in the ratio of 5:5:1. Another supplier recommends 95% wheatfeed and 5% yeast. The list of formulae is numerous, even among laboratories. Bran is often used, though wheatfeed has a higher nutritional content. It will, however, prove more difficult to obtain in small quantities.

For the amateur, a mixture of rolled oats, whole-wheat meal and bran in equal quantities and a generous helping of inactive yeast constitute a good base. On top of this mixture should be placed several layers of hessian sacking or a thick layer of shredded paper for the adults to crawl about in and lay their eggs. Damp, crumpled tissue will provide moisture, as will slivers of potato, carrot, apple or banana skin. It is important to avoid an excess of moisture as high humidity will encourage mould and mites. Large cultures can be started with 50-100 beetles, smaller ones with half that number. It is important that initial stocking is not overdone for resultant progeny may be more than the culture can cope with, resulting in overcrowded and soiled conditions. New cultures should be started every 4-5 weeks to give continuous production.

Feeding to Stock: Worms can be sieved to separate them from the food medium, or a light-weight flat-bottomed object can be placed in the container - larvae will then congregate underneath and can be easily removed. This latter method is useful for recently emerged larvae, which need to be extracted. When offering mealworms to stock, they should not be placed in the same container as other livefoods for any length of time as they will eat flesh if given the chance, especially the soft flesh of pinkie mice. Shallow containers need to be smooth-sided as the grubs can scale rough surfaces.

Many bird-keepers feed in hook-on feeders attached to aviary wire. If these feeders are accessible to mice, they will nibble and kill the worms overnight. This will result in what was thought to be an adequate supply to cover the morning, being absent. This could prove fatal to newly hatched chicks where the first feed of the day is crucial to their survival.

Life Cycle: Females begin to lay eggs 7-10 days after emergence from the pupae and peak production will last 5-6 weeks before tailing off. Eggs hatch in about two weeks under optimum conditions and a full cycle is completed in six months at 21 °C and four months at 26 °C. A higher temperature can reduce the life cycle still further but it will self-test if humidity levels are correct.

BUFFALO WORMS

Until recently, *Alphitobius dinperinus* was known as the Lesser Mealworm but since its popularity has increased to the point of it now being commercially available, it is now known by its more familiar name of Buffalo Worm. They were first noticed when crickets became widely available as a livefood, for the conditions that suited them also suited the Buffalo Worm and commercial supplies usually contained a number of adults and larvae. Although several zoological gardens bred them, it is only comparatively recently that commercial breeders have reared them for general sale. It is now a very important food item and the one that should be offered in preference to mini mealworms to newly hatched stock or difficult feeders as the grub is both small and active.

Obtaining Stock: By purchasing as larvae and growing on. May also be acquired by accident, in limited numbers, in supplies of crickets bought as livefood. Even a small number of beetles are ample for starting a culture.

Housing: Large glass jars with screw-top lids are ideal. Into the lid should be cut as large a hole as possible to allow for a twin-layered ventilation and mite exclusion cover. This is best effected by means of gluing a piece of filter paper or blotting paper and fine weave muslin in position.

Culturing Procedure: Culture jars should be just over half-filled with the food medium of wheatfeed (or bran), fish meal and inactive yeast in the ratio of 8:6:1. On this should be placed a piece of tissue

paper to give extra surface area for adults to walk on. Moisture can be provided by damp cotton wool. Starting new cultures every three weeks or so with about forty adults will give a continuous supply of grubs.

Life Cycle: About twelve weeks but can be slightly less if conditions are constant throughout the cycle.

CONFUSED and RED FLOUR BEETLES

These two small species, *Tribolium confusum* and *T. castanium*, are very similar to each other, both in appearance and in their requirements. Both are serious pests of stored grain and care should be taken that none are allowed to escape, especially if cultured indoors - cornflakes could prove more nutritious than stated on the packet! These beetles form a readily taken source of livefood and are highly recommended, being one of the easiest to culture although rather interestingly, they are not yet available from normal commercial sources in the UK. They are, however, available commercially in the USA.

Obtaining Stock: Obtainable through Philip Harris Education or, occasionally, from research laboratories.

Housing: Best kept as for Buffalo Worms with twin-layered ventilation and mite protection incorporated into the lid.

Culturing Procedure: As with all beetles, a number of smaller cultures should be kept rather than a single large one. A wide range of cereals can be used as food though these two beetles feed and breed quite profusely on a mixture of whole-wheat flour and inactive yeast in the ratio of 12:1. Jars should be half-filled with this mixture with moisture and extra walking space provided as for Buffalo Worms. Start new cultures every four weeks with about 40 adult beetles.

Life Cycle: Owing to their smaller size, a complete cycle can take as little as four weeks if kept in optimum conditions. Sexes, of both species, can be distinguished at the pupal stage using a magnifying glass. However, for the amateur, sexing is not an essential requirement.

DRIED FRUIT BEETLES

A disadvantage with *Carpophilus hemipterus* is that it is not readily available from the usual sources and may be difficult to obtain. The larval stage is different to that of the flour beetles, being softer bodied and with an appearance more like that of a waxmoth grub.

Obtaining Stock: May be available from Pest Research Laboratories.

Housing: Large glass jars are suitable but, with this species, fine wire gauze must be incorporated in the lid, ensuring that it sits flush with the jar top when in place. Adults are able to chew through other materials and, though they rarely climb, the metal gauze will assist in keeping them in their rightful place. However, because of their diet and liking for warm temperatures, they are unlikely to become established even if they do manage to escape.

Culturing Procedure: Jars should be half-filled with a food medium of rolled oats, sultanas and dried inactive yeast in the ratio of 6:6:1. Tissue paper and cotton wool should be included as for other species to provide walking area and moisture. Between 40-50 adults can be used to start new cultures, which should be done every six weeks. Keep at around 28 ºC, a slightly higher temperature than other species of beetles require.

Life Cycle: Comparatively short. Between 5-6 weeks under optimum conditions.

BLOODWORMS

Not a real worm, but the larval stages of a group of midges which live in mud at the bottom of lakes, rivers and ponds, and in sludge at the bottom of rainwater storage barrels. Such barrels can be a very useful piece of equipment for anyone contemplating the culture of aquatic livefood. They can be set up solely for the supply of rainwater as a medium for brine shrimps, *Daphnia* etc. but if left uncovered with a wire netting top and a soil sediment, both bloodworms and mosquito larvae will materialise.

Collecting: Bloodworms occur in most types of water quality and as such are not good indicators of pollution. Hence other indicators must be used to ensure they are obtained from a clean source. Once a suitable site is found, collecting can be done by scraping off the top 7 cm of soft mud and sifting the worms out by gently swishing it back and forth through the water. Metal sieves are useful for this but finding one large enough may be a problem - hardware stores and garden centres are perhaps the best bet.

The resulting worms and debris can then be taken home and placed in shallow pans overnight. By the following morning, the larvae will have congregated into balls and can be easily removed. If not fed straight away, they can be kept for short periods in jars of rainwater and fed minute amounts of dried yeast.

Culturing Procedure: Culturing bloodworms out of doors can be done easily. A suitable enviromnent is a plastic washing-up bowl with fine mud on the bottom and three-quarter filled with pond or rainwater. Placing it in the shade, especially in a damp area, will usually be enough to attract midges. Eggs are laid in late summer or early autumn and provide worms in the winter. The colony may need to be fed, in which case, dried milk, yeast and liquid manure (as described for *Daphnia*) can be used. Be careful not to over feed.

BRANDLINGS

Compost heaps are a productive habitat for many creatures, none more so than for the Brandling or Tiger Worm *Eisenia foetida*. This ringed species of worm is abundant in organic rich material and is the worm used by gardeners in their compost drums. The worms have a strong odour, which may put some species off taking them, but perseverance may well pay off as many species do take a time to become accustomed to new foods, especially species that are otherwise given little variation in their diet.

Obtaining Stock: Searching leaf litter or turning over compost heaps is a good source.

Housing: No special requirements are needed, unless you plan to use one of the commercial drums that are rather expensive. A heap of mixed leaves or well-rotted manure will do adequately, to which can be added garden waste and kitchen scraps. Alternatively, a hole in the ground can be dug and filled with the medium. Then it is a question of adding the worms and waiting for numbers to increase. The decomposing vegetable matter will provide all the food that is needed.

Feeding to Stock: Because of their food medium, worms should be cleaned prior to feeding. A gentle rinse under a running tap will do if feeding to fish but they should be left overnight in damp hessian or cloth, to allow the gut to clear its contents, before feeding to other livestock.

BRINE SHRIMPS

The commercial Brine Shrimp used as fish food is native to the salt lakes of the USA. Their life cycle is such that at the end of their breeding season, after numerous broods of live young, females produce eggs by the million which over-winter to hatch the following spring. These eggs are collected

and separated from associated debris before being dried and packaged. In this state, eggs remain viable for many years.

Obtaining Stock: As eggs from specialist suppliers or by post through publications which cater for aquarists.

Housing: To hatch eggs is a relatively simple matter and a variety of containers can be used. To four litres of water add four tablespoons of salt, preferably rock or sea salt which contains no added iodine, or use one of the commercial salt preparations available for tropical marine fish. Add ¼ teaspoon of eggs and stir vigorously to get them soaked. Continuous agitation increases the hatch rate and can be easily achieved using an aquarium air pump. Placing a "T" connector in the line going to the aquarium airstone will usually suffice for small cultures but purchasing an air pump with two lines, one each for the Brine Shrimps and aquarium or one that has four outlets can be used specifically for setting up a number of cultures. If using a pump to aerate both a tank and shrimp culture, ensure that it is placed above both to prevent siphoning should the pump fail.

Life Cycle: Eggs take a week to hatch at 18 °C, two days at 20 °C and one day at 26 °C. Once hatched the young shrimps can be siphoned off and fed to fish - they make an excellent first food for many young fish. The easiest way to perform this, especially if hatched in glass jars, is to place a light source, either a torch or light bulb, at one side and this will encourage the newly hatched nauplii to congregate there away from hatched egg cases. They can then be netted or siphoned off. Rinse thoroughly in clean water to rid them of salt before feeding to stock.

From hatched nauplii to adult shrimps takes about three weeks and twelve moults. Rearing to adult stage is best done outdoors and in containers as large as possible if a good number of shrimps are required. Indoors, twenty litre plastic aquariums can be used. These should be well lit to allow a growth of green algae on which the developing shrimps can feed, but do not allow the water to heat up too much. Yeast and lettuce can also be used as food, as can infusoria (see p.24) and one of the commercially available foods for the fry of marine fish.

As adults, they provide excellent food for larger fish and other aquatic creatures. They should first be washed but with salt-water feeders such as certain wading birds, this is not that important.

BUTTERWORMS

Butterworms are the larval stage of the Chilean Moth Chilecomadia moorei. They have a high Calcium and Protein content, although the Fat content is a little high for continuous feeding. They are also known as the Tevo or Tebo worm.

Moisture	58.54%
Ash	1.04%
Protein	16.2%
Fat	5.21%
Calories	87.7
Calcium(mg/100gm)	42.9

Many countries see the Chilean Moth as a pest and for this reason they are supplied irradiated. They can be sourced from many UK suppliers.

Storage: Store in a refrigerator in a dry substrate such as wheat bran or wood savings. The Butterworms will go into a hibernating state and can be kept this way for up to 4 months without feeding.

CALCI-WORMS

Calci-worms, also known as Phoenix Worms are the larvae of the Black Soldier Fly (Hermetia Illucens). They are unsuitable for breeding and should be treated as a food source only. They have an ideal Calcium/Phosphorus ratio and are reputed to have other (unsubstantiated) health benefits. They can be bought in various sizes up to 18mm long.

Fat	9.4%
Protein	17.3%
Calcium	8155ppm
Phosphorus	5355ppm
Ca/P Ratio	1.52

Storage: They do not require feeding and will keep for weeks at a cool room temperature 10 – 15 C.

COCKROACHES

Not, it must be said in all fairness, one of the most desirable of livefoods to culture for the hobbyist, but one that can be bred quite easily. A number of species are obtainable but the German *Blatella germanica*, Oriental *Periplaneta orientalis* and American *P. americana* are the most suitable with the first named having the shortest life cycle. Cockroaches have an offensive smell and are not taken by as wide a variety of species as are crickets, which are a far better proposition for home use in my view.

Obtaining Stock: From biological and entomological suppliers. Colleges or schools may maintain cultures and may be able to help. More rarely from buildings with an infestation.

Housing: Deep, glass containers are essential and, besides a tight fitting lid, a coating of Vaseline should be applied to the top 5 cm or so as an extra precaution. It is also advisable to carefully check the lid before opening their container. Every precaution possible should be taken to prevent an escape. They are unsavoury creatures to have at liberty and extremely difficult to capture once they have escaped. Containers should have sawdust or peat as a base and incorporate either crumpled newspaper or cardboard egg trays to create additional surface area and hiding spaces. Ventilation is important and strong, very fine metal mesh should be used. A warm (28 °C) dark place is ideal but, at these temperatures, cockroaches are very active. Before removal, the culture should first be cooled and, after removal, and whilst still relatively immobile, should be fed to stock.

Diet: A wide variety of dry foods are acceptable; pelleted poultry or rodent feeds, dry biscuit, stale bread and breakfast cereals are all suitable as is potato, apple and lettuce. Commercial diets intended for crickets can also be used. Damp cotton wool or a "water bottle" (see p.6) is useful for supplying moisture.

Breeding: Laying females carry an egg case (ootheca) around with them for several hours before eventually sticking it to a suitable surface or burying it. The ootheca contains the eggs, which hatch in 30 to 50 days depending on the species and colony conditions. Research on the American Cockroach has

shown that, under varying conditions, between 12 and 58 egg cases can be laid at intervals of 5-7 days once a female reaches maturity.

Life Cycle: Incomplete metamorphosis with nymphs progressing through a number of moults, usually 9 to 13 before reaching the adult stage. For several hours after each moult, the body is white but soon darkens. Development time depends on temperature but is about six months at 28 °C.

CRANEFLIES

The term "Daddy Long Legs" is applied to various species of cranefly, in particular, the grey-brown *Tipula paludosa*, commonly found around gardens in the early autumn. Adults live for about four weeks. Over-wintering occurs at the larval stage, known as "leatherjackets", which are often encountered during the spring as a garden pest. Feeding on plant roots, the larvae can cause considerable damage especially to commercially produced crops.

Collecting: Adult craneflies are relatively slow fliers and can be netted or simply caught by hand. Where larvae occur in reasonable numbers, adults can be picked off the grass shortly after emergence. In the early spring and in a good area, usually grassland of some type, larvae can be encouraged to come to the surface by employing the same method as adopted for catching earthworms. Watering the ground in the evening and covering with a black polythene sack will usually bring a number to the surface by the following morning. Larvae are given the name leatherjacket because of their tough skin, but they are, none-the-less, a useful livefood for the species able to cope with them.

Breeding: Not very practical, but can be achieved quite easily if desired. The prime requirement is an area of grass, which should be cut to about 5 cm high. The height is not critical but allows for easy viewing of laying females. The area should be netted over and a number of females (see below) placed on the turf. As many females are mated shortly after emergence, the provision of males is not important if sufficient females are used. Larvae are subterranean, feeding on grass roots and, as such, it is unlikely that a small area could support a large enough number to make it of benefit, other than for experimental purposes. However, the 1 mm long shiny black eggs may be taken by fish with perseverance. If being kept solely for eggs, the breeding pen needs very short-cropped turf to allow the eggs to be clearly visible when laid. When only a small number of females are kept, a covered seed propagator with a short cut turf on the base will suffice. After a day or so females can be fed or released.

Sexing: Easily distinguished by the terminal abdominal segment. In the male it is rounded whereas it is V-shaped in the female.

CRICKETS

Of the commercially available types of livefood, the House Cricket *Acheta domestica* is one of the most nutritious and eagerly accepted, being taken by a wide range of species. They can be used as a food either dead or alive, will freeze well and are one of the least demanding to culture given the right conditions. Several other species of crickets are available but their value as livefood for home culture is questionable owing to a less gregarious nature or more exacting dietary requirements. The black and gold Field Cricket *Gryllus campestris* and more recently, the Silent Cricket *Gryllus assimilis* are bred by an increasing number of commercial suppliers. Details below relate to the House Cricket, which seems to lend itself more readily than the other two species to home culture.

Fat	6.0%
Protein	21.3%
Calcium	345ppm
Phosphorus	4328ppm
Ca/P Ratio	0.08

Obtaining Stock: As adults or advanced instars purchased from commercial breeders in quantities of 100-1000. Eggs can occasionally be purchased from biological suppliers but this is not a practical way to commence culturing.

Housing: Many types of containers can be used, the size and type of which depends on how extensive the culture will be. Glass jars are adequate, but plastic aquariums are by far the most suitable for small cultures. Larger cultures can be distributed amongst a number of aquariums, a large plastic water butt, a dustbin or the base from a kitchen waste-disposal bin. Crickets are adept at climbing plastic, so several coats of gloss paint should be applied to the inner top 5 cm or so, to assist in retaining the insects. Black netting, glued or stapled to a wooden frame, is ideal for a covering or, alternatively, netting can be held in place by means of a loop of elastic around the rim. Having taken every precaution, it must be said that anyone culturing crickets and not having them escape at some point is exceedingly lucky.

As a base, either moist peat or sand can be used, though preferably the latter for it is easier to moisten when dry. Extra surface space must be provided in the form of crumpled newspaper, loosely rolled lengths of cardboard or cardboard egg trays. Gardiner (1981) suggests the use of inverted cardboard flower pots, two or three of differing sizes nestled inside each other with a number of access points cut into each. A number of these 'nests' per culture are ideal and, when crickets are required, the removal of the top one should provide a number of crickets. These can then be shaken into a polythene bag for cooling or transporting. A cardboard tube from the centre of a toilet roll, plugged at one end can also be incorporated for the same purpose. Crickets will soon congregate there and they can be removed from the culture simply by placing a hand over the open end of the tube. Crickets are lovers of heat and a temperature of around 25 ºC is ideal, although they are capable of coping with much higher temperatures.

Adequate ventilation is important otherwise the colony tends to sweat and becomes prone to fungal and bacterial infection. Adults should always be kept separate from eggs and early instars as they are not averse to making a meal of them.

Diet: When starting a culture an initial check should be made to ascertain food consumption though it is not critical that food and water be renewed daily. Two or three times a week is quite adequate providing attention is paid to the cultures' condition, ensuring that it does not become soiled or, in the case of moistened food, turn rancid.

Numerous diets have been fed to crickets with varying degrees of success. A pelleted rabbit or poultry food obtainable from pet shops is readily consumed. The only question regarding this form of diet is whether the antibiotics contained in these pellets could cause reduced fertility or, in some instances, sterility in the crickets or the livestock to which they are fed. Dry bread, breakfast cereals of various types and crushed biscuit are also eaten. A dry mixture, which has a high nutritional content, is made from biscuit meal, Bemax, dried milk and inactive yeast in the ratio of 10:8:1:1. All dry ingredients should be fed in shallow containers. Commercial diets are also available, with those produced by Livefood Direct and the International Zoo Veterinary Group highly recommended. Lettuce, apple and potato can also be given. Damp cotton wool or sand should be available as a permanent source of moisture.

Vegetable matter tends to dry after a short time but is, none-the-less, useful as an additional source of moisture and food. If the culture is to be left for longish spells, a "water bottle", as described on page 6 must be provided, as can 'solid water'. On no account should water in open dishes be given, as drowning can occur, especially with the young nymphs. If kept short of water, cannibalistic tendencies can develop within the colony.

Life Cycle: Three to four months at 20-25 °C. Temperatures of 30-35 °C can reduce this by half.

Sexing: Females are easily distinguished when adult by their long ovipositor, which protrudes from the abdomen.

Egg-laying: Generally long-lived creatures, the egg laying capacity of a female is high and a thousand or so eggs can be expected under optimum conditions. A changeable vessel, for the laying of eggs, must be supplied and can consist of a variety of containers, dependent on the size of the culture. Eggs are generally inserted down the sides of the container by the ovipositor but, frequently, random laying takes place. A small shallow dish is adequate for a small colony but larger colonies should be provided with a 500 g margarine tub with several plastic strips inserted across to provide more surfaces to lay against. Peat should be used as a laying medium. If possible, heat sterilisation in an oven or microwave will help to cut down the risk of harmful bacteria. A batch of sterilised peat can be prepared and stored in a sealed plastic bag for later use. Before using, it should be thoroughly soaked with water to restore moisture after which it should be squeezed to remove the excess. When crumbly, it is of the right consistency and, once installed in the breeding unit, should not be allowed to dry out. Successive laying vessels must be provided every two or three days, especially in large colonies where the laying of too many eggs will often result in those underneath not hatching or producing deformed nymphs. Eggs are opaque, about 3 mm long and take about eleven days to hatch at 32 °C, longer at lower temperatures. Eggs can be hatched by placing both the eggs and laying medium into a suitable container in the warmth (an airing cupboard is ideal) or in a temperature regulated incubator. On hatching, nymphs are minute replicas of adults and progress through a series of moults until the adult stage is reached.

Feeding to Stock: Crickets are active creatures and readily seek out cover. For this reason, when fed as a livefood, they should be immobilised in some way. The best means of accomplishing this is by chilling in a refrigerator for several minutes prior to feeding. Alternatively, they can be placed in a shallow bowl of water, which will restrain them for a brief period. Special dispensers are now available which allow crickets to escape very slowly.

When chilled, they can be coated with a multi-vitamin powder to increase their nutritional value. Several preparations have been developed specifically for use with this insect and formulated with the sole aim of increasing the calcium to phosphorus ratio, so important in preventing bone deformities in stock.

DAPHNIA

Water fleas of the genus *Daphnia* abound in suitable still waters where little vegetation is present. Ponds and water-filled ditches are the most likely places to encounter this, a much-prized livefood used by aquarists. It can become very abundant where ideal conditions prevail.

Obtaining Stock: By collecting from the wild with a fine mesh net or by purchase from outlets which supply the needs of aquarists. The trouble involved in searching for a suitable location to collect from will prove worthwhile especially as the area is then likely to be teeming with them. Ponds, ditches and even puddles are worth exploring! Purchasing can be rather expensive but if all else fails, it will still prove valuable to livestock and if used for breeding on, providing conditions are met, numbers will soon increase quite considerably.

Housing: A wide variety of containers can be used, limited only by the size of culture to be maintained. For year round cultures, large drums sunk into the ground can be used but precautions must be taken to prevent the water from freezing. Covering with hessian sacks and straw will prove adequate if the drums are positioned in a sheltered area in the first instance. For smaller indoor housing, plastic aquariums are fine and a number of these can be used in sequence if a large quantity of *Daphnia* is required. Washing-up bowls are also useful.

Culturing Procedure: Whichever containers are used, they must be thoroughly cleaned to ensure that they are free from algae before commencing the culturing procedure. They are then filled with aquarium, tap or rainwater and allowed to stand for several days. Pond water can be used but is best avoided as it may contain predators such as *Hydra*, a creature that not only attacks the *Daphnia* but also small fish fry. *Daphnia* can then be added. The culture should be fed (see below) and will soon multiply.

When harvesting, only a quarter of the batch should be removed at any one time, hence the need for a number of cultures. Cultures can be kept outside during the spring, summer and early autumn months but should be brought inside from late September if year round production is required. Should cultures decrease in vigour, strain out the *Daphnia* and introduce into a new tank. Wash and dry the used equipment thoroughly.

Breeding: When conditions are right, the colony will multiply through live birth. Females produce eggs that develop in brood pouches and hatch into females. A cycle which is repeated every ten days or so until the population is dense. Shortage of food or a drop in temperature will cause the developing eggs to produce some males. Mating then occurs and the eggs are released directly into the water. Such eggs can be collected with a fine net from the water surface and stored in a cool, dry place until the following season. Eggs can be induced to hatch, if required, by alternatively freezing and thawing them six to eight times before finally placing them in water to hatch. Chilling or overcrowding is normally enough to trigger the process for production of winter eggs.

Feeding: *Daphnia* are organic feeders and eat a variety of items including both water-based and water-soluble ingredients. Green water, liquid manure and leaf-stained water are natural foods. Dried yeast, dried milk and the yolk of hard-boiled egg can also be used and should first be mixed with water, making sure they are fully dissolved before placing in the tank. Knowledge of the correct amount of food to offer will soon be gained through experience. The initial policy should be "little and often" rather than one large feed, otherwise the food may turn sour if not eaten within a short space of time. Food should not be added to a cloudy culture, only when it clears signalling the colony has then exhausted its food supply, is there a need to provide more.

Preparation of foods for Daphnia

Green Water: The active constituent of green water is algae, which is ever present in vast numbers. It can be collected from the wild or produced by placing a leaf or two of lettuce in a well illuminated jar of unchlorinated water. Several jars can be maintained, with new cultures being started periodically using inoculations from established batches.

Leaf-stained Water: An abundant source can usually be found in puddles and ditches but it can easily be made by placing a number of dried leaves in a jar of unchlorinated water. Avoid pine needles as they are far too acidic.

Liquid Manure: Add a teaspoonful of dry animal dung (chicken, horse or sheep) to four litres of water. To this add one litre of water filtered through rich garden soil. For filtration a coffee filter paper or plug of cotton wool placed inside a plastic funnel will serve the purpose if the water is poured slowly.

EARTHWORMS

Earthworms are a most useful form of livefood for many species of animals, being both easy to collect and to culture. Care must be exercised with certain species of birds, particularly starlings and gamebirds, for earthworms are a carrier of *Syngonius*, which causes the condition known as Gapes. The most frequently encountered species of worms are *Lumbricus terrestris* and *Allolobophora conga*, the cast making species so abundant on lawns in spring and autumn. These worms can be collected and cultured using the methods given below.

Collecting: Although earthworms may be purchased from breeders throughout the year, collecting in the spring and summer months is a simple matter. Worms are most abundant where the soil is rich and relatively moist. In hot weather they tend to burrow deep into the ground and become difficult to locate. Several methods can be employed to catch worms. Digging is most useful but may not be practical if the only piece of available ground happens to be a flower border or a vegetable patch. Worms can also be

gathered by torch light, late on a spring evening during, or just following, rain. Baiting is also productive and is simply a matter of placing hessian sacks over leaf litter and baiting them with kitchen scraps or tea leaves. In a short time worms will be attracted and can be collected. A hessian or black plastic sack placed on a lawn overnight and pegged down to stop it blowing away, should yield quite a number, especially if the ground is given a good soaking with water beforehand. Using this method it is advisable to remove sacks during the day otherwise grass turns yellow if deprived of daylight for any length of time. Placing sacks in a different area each night, or every couple of nights, will maximise the numbers of worms collected and reduce the risk of incurring displeasure at seeing unsightly patches on otherwise pristine lawns.

Housing: A variety of containers can be used but, for obvious reasons, the larger they are the better. Boarding, lined with black polythene is ideal for large outdoor housing. Do make sure drainage holes are adequate! Minimum depth needs to be in the region of 30 cm with a soil medium of equal parts leaf loam or rich garden soil and partly decayed tree leaves. The mass must be kept moist but never allowed to become saturated - good drainage or a cover will help control moisture levels. Damp hessian sacks placed over the vessel will help to maintain humidity and to stop its contents drying out. Earthworms are susceptible to over-heating so cultures must be kept cool and to preferably be in the shade. Temperatures above 18 °C can prove fatal. Perhaps the most suitable way of keeping earthworms is to dig a hole in the garden, in shade if possible, filling with alternating layers of rich garden soil and deciduous tree leaves. Cover with a hessian sack and frequently sprinkle with a little water. The addition of fine grit to the colony is beneficial as this aids digestion. Some worms will move out into the surrounding soil but most will remain.

Breeding: If worms are housed and fed correctly, nothing else is required to encourage breeding. All species are hermaphrodite, although sperm will more often than not be exchanged between individuals.

Food: The leaves and soil of the culture medium will provide all that is required in the way of food but other items can be given occasionally. Mashed potato, tea leaves, powdered cereals and kitchen scraps are eaten by worms and they are reputed to be very fond of chocolate!
Feeding To Stock: Allowing earthworms to crawl through wet moss or sacking for a day or so will help to clear their gut of debris. Also, they may be washed, if desired, but should not be left in water for any length of time, as they will soon expire.

EARWIGS

Two species of this fairly small family are common in the British Isles. *Forficula auricularia* is the largest and most frequently encountered. Earwigs are single-brooded and therefore of limited use as a livefood although, if sufficient females can be caught at the right time of the year, it is worth setting up breeding containers. Adults, at any time, and eggs and nymphs in spring, provide a useful addition to the diet of those species that will take them.

Collecting: Searching under loose bark and around out-buildings usually proves fruitful, as does periodically opening windows and doors which are normally kept closed for long spells in autumn and winter. During the summer months, both sexes can be trapped at night by using a flowerpot, loosely packed with newspaper, hay or straw and placed upside down on a short stick, which is pushed into the ground. The contents can be shaken out into a bucket the following morning. Locating between or near Dahlias is likely to be productive, as earwigs are a considerable pest of these plants. If being retained for breeding, summer caught specimens can be housed together but, from early autumn, only females need to be kept as mating is likely to have taken place. At this time of year, males are near the end of their life expectancy and can be fed to stock.

Sexing: An inspection of the abdomen shows it to end in the characteristic forceps, these possess a pronounced curve on the male while those of the female are almost straight.

Housing: Almost any container can be used but it must have a tight fitting lid for exploring earwigs, especially the early nymphal stages, are excellent climbers. A layer of soil, at least 3 cm deep, is ideal as a base and must be kept moist. Cover can be provided in the form of hollow cane (bamboo with the pith removed), pieces of bark, leaf litter and broken-up pieces of rotted wood. Being gregarious creatures, a fair number can be housed together. They require no heat and two or more containers can be kept in service with little trouble. An outside shed or building is a good place to keep them. The raising of the lid to feed every day or so will provide enough ventilation, although a very fine meshed metal grill can be incorporated if the container allows it. Periodically, a light spray with a fine mister will help to maintain the humidity level, which should be kept fairly high.

Food: Being omnivorous, a wide selection of food stuff are eaten. Small slices of apple, potato, carrot and lettuce are suitable vegetable matter with the carcasses of insects, spiders and woodlice providing animal protein, as would the occasional chop bone. Experimenting with other items could also be worthwhile.

Life Cycle: Twenty to forty, occasionally as many as sixty, whitish eggs are laid between January and April. These are attended to by the female until they hatch, as are the nymphs for the first week or two of their lives. She then dies. Nymphs have an incomplete metamorphosis, passing through six moults in the three or four months required to reach maturity. The life span of females is slightly over one year while that of males is only six months. Mating usually takes place on reaching maturity in the summer months.

Culture Management: Females can be removed for feeding to stock once the nymphs are independent. Depending on size of the culture required all the young from the first year should be retained until the autumn by which time mating will have taken place. Males can then be fed to stock. Subsequently, when the culture is established, numbers can be taken, as required, for feeding or to set up new colonies.

FLIES

Many species of flies are found in the wild, several of which are familiar to most people. These notes refer to the common blowflies and houseflies. The true value of the various stages of fly development, as livefood, is open to conjecture. Their use in recent times has decreased, especially with aviculturists, since the discovery that the larval, or maggot stage, the one most frequently used, is a carrier of Botulism. Other stages may transmit it also.

If purchasing maggots, a reputable supplier should be found rather than buying from a local fishing-tackle shop, although alternatives to the latter are decreasing, almost non-existent. The colouration of maggots is now achieved using vegetable dyes which are believed to be perfectly safe. Previously, some of the dyes used were potential carcinogens. Maggots should be allowed to clean themselves for several days in fresh sawdust or bran before feeding. The gut, a visible black line within the body, should be as free as possible of food, appearing clear, not dark, before feeding to stock. Maggots, used prior to pupation, have a low nutritional content because they live off body reserves during the last few days of that stage.

The one great advantage of fly maggots is that their normally semi-liquid existence allows them to be coated with a variety of liquids and still survive, a distinct advantage they have over mealworms which succumb very quickly in moisture. In fact, all maggots fed as livefood should be coated with a liquid vitamin preparation and dried off with a powdered feed such as the baby cereal, Farlene. This not only adds to their nutritional value but also stops them escaping from feeding containers. The feeding of commercially bred maggots, irrespective of how well they are cleaned, must be considered a risk, especially to birds.

The continuous breeding of flies is not considered to be a socially acceptable proposition for "back-yard" production for the smell can become unbearable after a short time. It is possible to produce small quantities with little trouble and it is hoped that at least one of the five methods detailed below will prove satisfactory for those wanting to try!

Method l

Place bran in a container and put a piece of liver or a little minced meat on top of it. Positioned out in the open this soon becomes fly blown. Maggots should be visible after a few days. Bran will need to be sifted and renewed if it becomes too soiled. Maggots should be allowed to clean themselves in fresh bran for several days prior to feeding.

Method 2

The bluebottles *Calliphora vomitoria* and *C. erythrocephala* found buzzing around indoors during the summer are most likely to be females, attracted by smell and looking for a place to lay their clusters of eggs. These flies can be caught and placed in a simple container comprising a dish and a sheet of glass or perspex for a cover. Preparation beforehand is a layer of damp soil about 3 cm deep in the bottom of the dish and a lump of meat the size of a walnut for food. Within two or three hours, batches of eggs will have been produced. Females can then be dispensed with as death usually follows laying. Maggots should soon appear. Clean well before feeding to stock.

Method 3

A large biscuit tin with a tight fitting lid is required. First cut a 5 cm hole in the lid and then place a chicken carcass or pigs heart in the tin and replace the lid. Leave outside for several days to become blown. Wrap the food in an old newspaper and replace it in the tin. The eggs will soon hatch and, from then on, periodically check the maggots progress. Once full grown, transfer to bran for several days to clean. By using this method, a number of species will be attracted to the bait.

Method 4

Artificial diets have been developed for the rearing of the House Fly M*usca domestica*, many of which involve the removal of eggs from bait to a culture medium. This is easily effected with a fine paint brush or by scraping with a sharp knife. Bait, consisting of a substance normally used for depositing eggs, is needed to induce laying, although some females will lay on an artificial diet. Several diets have been developed, some of which are commercially available, but the following formula is, perhaps, the easiest and cheapest to prepare - mix 2 parts fishmeal, 2 parts ground rabbit pellets, 2 parts dried inactive yeast, l part molasses and 6 parts bran with enough water to make the whole damp but not wet. Place in jars and "seed" with eggs. Seal with fine mesh held in place with an elastic band.

Method 5

An artificial diet has been used to attract a variety of blowflies in America and may well be successful with other species belonging to the *Calliphoridae*. Preparation is simple using powdered milk, Brewer's yeast and hot water in the ratio, by volume, of 1:1:15. Into this mixture, add Purina dog chow (or similar dry dog food) and leave until thoroughly softened. Drain or add more water as desired. Raw liver can then be placed on top of the mixture as an incentive to induce laying.

Life Cycle: The majority of species spend 24 to 48 hours in the egg stage, 5 to 10 days as larvae (maggots) and about a week as pupae. Egg-laying commences four to six days after emerging as adults. Mobility and growth rates of maggots can be slowed by chilling and, if flies are required for feeding to stock, a handful per day can be placed in a container in the warmth to encourage hatching - thus giving a staggered hatch. Avoid hatching in cool or overcrowded conditions, as this will increase the incidence of deformities.

Attracting: During the summer months, flies are easy to attract. Partially fill an ice cream container with water sweetened using either honey or sugar and place in the shade. Another method is to use a commercial attractant. The wasp and fly attractant available from Barratines Environmental Health is particularly successful. In both instances, ensure that flies can not get at the mixture by fitting a tight lid with small holes in it to release the smell.

FRUIT FLIES

The small flies of the genus *Drosophila* are perhaps one of the most important insects being cultured because of their suitability as a tool for genetic research. As such, more is known about the culture requirements of these creatures than perhaps any other. Several species are bred but the easiest, and the one generally available, is *D. melanogaster*. It is not native to Britain but is introduced with imported fruit.

Obtaining Stock: Numerous breeders offer cultures for sale. Alternatively, placing ripe bananas, in a container outside on warm days in late spring and early summer will attract adults fruit flies. They can be caught by placing the lid on the container and leaving it for several days, enabling any females to lay. A helpful Greengrocer is also useful for his waste bin is quite likely to have a resident population and the removal of some rotten fruit, preferably banana or pear, will usually be sufficient to begin production. A flightless form has been developed which has proved beneficial for feeding to certain animals. This form is available from suppliers and is generally listed as vestigial-winged. Its needs are identical to winged forms but care must be taken if a culture is to remain flightless - hybridisation with winged individuals soon makes cultures revert - the genes in winged forms being dominant.

Housing: Two methods, depending on circumstances, can be employed: (i) In open cultures, a method usually used by bird keepers who, for the most part, breed fruit flies in their birdrooms. (ii) In escape-proof vessels where culturing takes place in a house or laboratory. Plastic tumblers, milk bottles or sweet jars, stoppered with a plug of cotton wool wrapped in muslin or a piece of the latter held in place by means of an elastic band, are suitable for contained cultures. Livefood Direct now provide complete kits for contained cultures.

For open cultures, plastic ice-cream tubs are ideal, especially if fruit is used as a food medium. Two should be used, one placed inside the other with small holes in each corner, drilled in the top one to allow juice to drain. Some larvae escape through the bottom but in a healthy culture, this "loss" is negligible. Large jam tins and buckets can also be used for open culturing but preference should be given to stackable containers so the above procedure can be adopted.

New Cultures: In sealed cultures, the removal of flies for new cultures can be easily achieved by cooling the older one and removing the desired number of pairs (see sexing) by means of a suction pump and pooter or large eye-dropper. Five or six pairs should yield around 500 flies. Open cultures present no problems for when a container with fresh fruit is placed alongside an established colony, laying will soon commence at the new site. Start new ones every 10-14 days to ensure a continuous supply.

Diet: Numerous preparations have been used successfully to rear fruit flies. Many rely on simply placing fruit in their cultures, which proves relatively successful. Fruit alone is of little benefit to adult flies until it starts to ferment for flies feed off the yeast created by fermentation. A culture started with fresh fruit, of which banana is the most productive, should have a little dried yeast sprinkled on it first. This speeds the acceptance and subsequent egg production in the new culture medium. Commercially available diets to which water is added are available and are worthwhile if small cultures are to be maintained. Of these, the preparation from Livefood Direct is one of the cheapest and certainly on a par with, if not better, than most available. The advantages of using these commercial diets is that they are nutritionally balanced and contain a mould inhibitor.

For those who are a little more adventurous, an artificial diet is easily prepared using the following recipe - Fine oatmeal 180 g, black treacle 80 g, powdered agar 15 g, water 1400 ml and a little

dried yeast. Mix all ingredients (except yeast) and bring gently to the boil, stirring occasionally. Boil for twelve minutes, then pour into the culture containers while still hot. Allow to cool, scar the surface with a fork and sprinkle on a little yeast before making it available to the swarm or introducing flies to new culture bottles. The list of variations for culture mediums is endless and several others, usually of a more complex nature, can be gleaned from publications listed in the reference section.

Sexing: A magnifying glass or watchmaker's eyeglass (Watkins and Doncaster) are essential tools. Sexes are readily distinguished by counting the thorax segments. Females have the most, twice the number present in males.

Breeding: Cultures should be maintained in temperatures of 18-26 °C with 24-25 °C being the most productive. Lower temperatures will give a more protracted life cycle while extremes will normally kill cultures completely. Eggs are laid in the food mixture and soon hatch. The larvae burrow into this and grow rapidly. When ready to pupate they climb up the sides of their container, although some will pass this stage in the food mixture. A folded sheet of paper can be pushed into the food to give additional climbing space. Laying may occur within twenty-four hours of hatching from the pupae but is usually deferred until the second day. Peak production lasts for about a week, decreasing gradually over the next month or so.

Life Cycle: From egg laying to emergence as adults takes six to eleven weeks depending on the temperature but once the culture is set up properly, an almost continuous supply should be available if maintained correctly.

GRASSHOPPERS

Various species can be cultured but not in sufficient quantities so as to be a substitute for commercially available locusts. However, those wishing to experiment are advised to consult Comber and Hogg (1979) and Brown (1983). It is, perhaps, far better to collect them for use as a seasonal extra and to add variety to the diet. They can easily be kept in suitable containers if an excess is caught. Many species are being reduced in number by destruction of their specialised habitats, therefore, modest collecting must be restricted to the Field *Chorthippus brunneus* and Meadow Grasshoppers *C. parallus*, the abundant species encountered in grassland and meadows.

Collecting: Catching is a relatively easy matter, depending upon individual preferences. Personally, I prefer to collect in the morning before the heat of the sun causes them to become too active. Walking through grass usually disturbs them sufficiently to be seen. They can then be caught and placed in a container. Once the sun is up, they are much more active and not as easy to catch. Sweeping with a net usually proves successful. A sweet jar inside a carrier bag is an efficient way to store while collecting for it is easily carried while actually chasing. Once proficient, several can be caught before transferring them to the jar. When handled, grasshoppers exude a brown, sticky liquid from their mouths. This is defensive reflex bleeding and does not cause harm to the handler. Surplus grasshoppers can, if not being kept for immediate feeding, be frozen.

Housing: Practically any container of suitable size is adequate for the temporary housing of grasshoppers. A floor covering of sand with a grass clod or cut grass in a tub of water for food should be present. Damp cotton wool or an occasional light spray will provide adequate moisture.

GRINDALWORMS

The culturing details and life cycle for grindalworms are almost identical to those of whiteworms and as such, the account given (see p.39) covering that species should be consulted by those wishing to keep and breed them.

GUINEA PIGS

Guinea pigs were probably introduced into Europe by the Spaniards around the middle of the 16th century. They have been a commonly kept pet ever since and are now available in a variety of weird and wonderful colours with some forms having long fur while others sport coats radiating in a series of rosettes.

Obtaining Stock: From pet shops or direct from a breeder.

Housing: Pairs can be kept together in smaller cages but to maximise breeding potential per area, it is best to keep polygamous groups of one male to three females in large cages or runs.

Life Cycle: Up to three litters can be produced annually with between three and five pups in each. Gestation period is ten weeks and while solids are taken at around five days, it is at three weeks that full weaning takes place. Separation of young males from parents should take place at between four and five weeks, as they can be mature at this age and will mate with siblings or their mother. Female Guinea Pigs come into season every 16 days.

Food: Pelleted feeds, available from pet shops and agricultural feed suppliers, should be the mainstay of their diet. However, hay should be given which, besides acting as bedding, will also be eaten. Fresh grass, weeds, clover, dandelion, apple and cabbage should also be offered. Water should be given in a bowl or water bottle purchased from a pet shop. The latter is preferable, as it is likely to keep the water cleaner.

HYDRA

Green *Hydra viridissima* and Brown Hydra *Protohydra leucharti* are related to the sea anemones, jellyfish and corals. They are rather inconspicuous creatures that attach themselves to plants of a similar colour. Reproduction is either from eggs or by budding to form new individuals. Hydra is a much hated creature with fish-keepers for they feed on live prey and will attack young fry. Larger species of fish will eat them so their culture, in small numbers, would provide variety to the diet. Other aquatic creatures will eat them and if setting up a pond-life tank, their many forms will create much interest. Medium-sized containers should be used so as to allow easy access to food until the colony becomes established. Water should be unchlorinated, either pond or rainwater can be used, and, if placed outside in the shade, a steady temperature can be maintained.

Feeding: Food must be living, of which *Daphnia* is the most easily had, although washed Brine Shrimp nauplii can be used being careful that all salt is removed.

Collecting: In clear water conditions individual hydra can be seen on vegetation and they can be collected and placed in their housing container. In murkier water, plants will need to be inspected before transferring. Once in the tank, prop the plants upright. The hydra will either stay there or transfer to the glass or any rocks that might be present. The addition of several plastic plants, ideally the strap-like varieties, will prove beneficial.

Feeding to Stock: If plastic plants are used, simply place one in the aquarium and remove once the hydra have been eaten. Alternatively, hydra can be dislodged and scooped out with a sieve.

INFUSORIA

Infusoria is a general term used for microscopic creatures that abound in still water and which form an important part in the early stages of development of higher forms of aquatic life.

Obtaining Stock: The simplest method is to either use a quantity of established aquarium water taken from the top of the tank or to filter some pond water through a coffee filter or fine muslin.

Housing: Containers with as large a surface area as possible should be used. Plastic aquariums are ideal but washing-up bowls and wide-mouthed jars can also be used. The liquid medium should be unchlorinated water to which is added a small amount of aquarium or pond water. Set up a number of cultures to suit requirements and, when needed, start new ones to add vigour. Periodically use old cultures completely.

Feeding: A wide variety of vegetable matter can be given to maintain an infusoria culture, ranging from banana skin, dry leaves, cubed potato, rotting lettuce leaves, skimmed milk, spinach, cabbage, hay, grass and a whole host of other vegetable matter. Infusoria live on decaying matter and a quick blanching in boiling water of any plant material will help break down cells and aid decomposition. Care must be taken not to be over zealous with food as water may become too toxic if the culture is not sufficiently established enough to consume all the food quickly. Little and often is a good guide.

Feeding to Stock: This form of livefood is the most beneficial for young fish fry that is available. Strain several tablespoons of water from the top of the culturing tank, through fine grade muslin, directly into the fish tank. Infusoria passes through leaving debris to collect in the muslin, thus avoiding contamination of tanks holding delicate fry.

LABORATORY MICE

The familiar white mouse is the most frequently available but other colours can be obtained. Mice do have two main drawbacks, their smell and need for specialist housing which may put them beyond many amateurs. The odour is obnoxious unless they can be housed in an outside building and cleaned regularly.

Obtaining Stock: From pet shops or specialised breeders. Depending on size of housing, a ratio of one male to two or three females is desirable although, initially, stock may only be available in pairs. Suppliers are reluctant to part with odd females. These mice can be kept in individual pairs but this increases the volume of space and amount of equipment needed. Better to purchase additional pairs and feed surplus males.

Sexing: The presence of a scrotum is usually sufficient to identify males. If difficulty in sexing still persists, many females possess prominent nipples once they have bred. Females also have a short anus to genital gap, which is relatively hairless; in the male it is much longer and, usually, covered in hair. The young can be sexed quite easily using the anus to genital gap method. After sexing a number of mice it becomes quite an easy matter to undertake.

Housing: Unfortunately, there are no short cuts to housing these creatures, as they are able to chew their way through many materials. Robust cages can be purchased or ordered from pet shops. Two types are available, the "shoebox" which is small, about 30 cm x 12 cm x 12 cm, and is adequate for a trio of one male and two females. The larger size has twice the width and can accommodate a male and three females. Both cages are rather expensive, although less expensive small mammal cages, which tend to be less sturdy are available from pet shops. Each comes with a removable grill-type lid and has a recess for both food and a water bottle.

A large wooden box, made from thick plywood, with a tight fitting ventilated lid, can also be used, but check periodically for signs of gnawing. A deep floor covering of sawdust, wood shavings or similarly absorbent material is important to soak up urine. Whatever material is used, it should be changed as frequently as possible which will help keep the smell to a minimum. Bedding material must be provided which will be heaped in a corner to make a nest. Hay, fine grass, shredded paper and wood wool can be used.

Feeding: A pelleted diet is available from pet shops. Thought most likely to be available in small amounts it would be worth trying to find a source which could supply it in bulk as costs would be reduced. Pellet-based diets should be supplemented with items of fresh food such as bread and apple. Mixed grain can also be given, as can peanuts. Fresh water should always be available, ideally in plastic water bottles that are outside the housing with the nozzle poked through a hole. The type with a stainless steel tip is best as aluminium can be chewed and could cause poisoning.

Breeding: Mice are prolific breeders and start when relatively young, becoming sexually mature at a month old. After a gestation period of twenty days, young are born naked with their eyes shut. At this stage they are called "pinkies" and can be purchased as such for feeding to stock. Broods of 12-14 are known but females should be allowed only eight, as females tend to become very thin if allowed to rear larger broods. If this happens, females should be rested until they regain condition. Lactating females should have access to plenty of food and water otherwise their milk supply could dry up. Young develop rapidly. At twelve days old their eyes open and they are able to stumble about. At two weeks, they are able to eat solids but still take milk for several more days. If no fighting occurs beforehand, young can be separated from their parents at about two and a half weeks old.

Handling: Mice come equipped with the ideal handling device, a tail.

LABORATORY RATS

The laboratory rat and the many coloured varieties offered in pet shops are derived from the Brown Rat *Rattus norveigicus*. Their management regime is very similar to that of the mouse and will not be repeated here *en masse*, hence only information applicable to rats is included.

Housing: Similar to mice, only accommodation must be larger. Pet shops are the best places to locate suitable items to use as housing for rats. Provide adequate gnawing material to keep them busy. They can, and do, make interesting and friendly pets.

Diet: Standard rodent diets can be purchased from pet shops. However as rats are opportunist feeders, they can be offered virtually anything, although a good commercial diet is the most beneficial for it contains a balanced nutritional content. Bread, fruit, vegetables, peanuts, grain and most other items found in the kitchen can be offered periodically.

Breeding: Although it is possible to successfully keep, a male and up to nine females together, unlike mice, female rats object to other females in close proximity once they have a litter. Thus females should be separated as soon as they are obviously pregnant with bulging tummies. A litter can be expected every three to four weeks if pups are removed. Young wean in seventeen to twenty-one days.

Handling: For the most part as for mice, but heavy males should be picked up by the *base* of the tail to avoid shedding the sheath from the latter half. Pregnant females need to be picked up under the belly to avoid injury.

LOCUSTS

Contrary to most other insects, locusts actually do better if kept in overcrowded conditions and will not come to harm if deprived of food for short spells. Two species are normally available, the African Migratory Locust *Locusta migratoria* and the Desert Locust *Schistocerca gregaria*, both of which are easy to rear. However, *Locusta* is preferred because it has a shorter life cycle and is reputed to have a higher resilience to disease. *Schistocerca* fare better on a dry diet and are larger, but males may not become sexually mature where population densities of a culture are low. Other species, that are commercially available from time to time, are the Red Locust *Nomadacris septemfasciata* and the Tree

Locust *Anacridium aegyptium*. For the purpose of these notes, information relates to the Migratory Locust. Management of other species is similar, but their complete breeding cycle is more protracted.

Health Warning: An allergic reaction can develop when working with locusts. The initial symptoms are similar to a head cold with frequent sneezing, occasionally accompanied or followed shortly afterwards, by localised irritation on the arms and legs. Symptoms usually disappear overnight but the keeping of locusts should be discontinued. Failure to do so may result in a severe rash and a wheezy cough particularly in people working with large numbers. Bronchitis and even asthma may develop. The use of protective clothing, especially around the face and hands, can control the allergy. Species such as crickets are an adequate substitute for locusts and their breeding should be considered or expanded to compensate. The periodic purchase of locusts as a supplement can be done if protective clothing is worn when handling them.

Obtaining Stock: Fairly easy to obtain because of their suitability as teaching subjects. Available as first instar hoppers through to adults. See list of suppliers.

Housing: Several stages of accommodation are needed during their complete life cycle in order to separate breeding stock from developing young. A breeding box design developed over forty years ago is still used by most laboratories which need to breed large numbers of locusts. The unit is capable of controlling both heat and light, the most important components for maximum results. However, its price is likely to be prohibitive to the amateur.

A unit adopting the same principles can be made quite cheaply using plywood for the top, bottom, back and sides to form a l m cube. A rigid false floor, raised about 10 cm from the base must be provided to allow for the two to four egg-laying tubes to be inserted below "ground" level. A sheet of clear plastic, positioned between the false floor and roof, can be screwed to the front or fixed by other means to allow for easy maintenance. Ventilation should be provided by a section cut out near the top and covered with finely woven wire gauze, or by a series of small holes drilled through the wooden back. Heat and light can be provided by a light bulb placed inside the cage and one below the false floor. The wattage required depends on the location of the cage, and some experimentation will have to be done, but temperatures need to be 30-34 °C during the day and 28 °C at night. Caution needs to be exercised where electricity is being used - if unsure, consult an electrician. Access for daily cleaning can be through an aperture near the bottom of the cage. A piece of tin held in place by a single screw can be swivelled to open when needed. Branched twigs should be included, as adults like to climb. Specifically designed tubes can be purchased for egg-laying, or substitute containers can be used. The only criterion is that they be flush with the false floor and at least 10 cm deep.

Other containers, such as aquariums and sweet jars, are of limited use other than for temporary housing. To bring on young hoppers, a larger wooden box with a tight fitting Perspex front panel and lid is required. A number of these will be needed for rearing hoppers of different ages. Feeding hatches, lighting and heating as per breeding box. Dry, branched twigs must be provided to enable developing hoppers to shed their old skins, otherwise deformity will occur, resulting in a high mortality rate.

Life Cycle: Locusts have an incomplete metamorphosis and, when provided with the correct conditions, can produce a complete generation in about nine weeks.

Egg-laying: Tubes suitable for egg-laying are available from Philip Harris Education. These should be lightly packed with moist, rather coarse sand lacking any large pebbles. Females bore a hole vertically, 10 cm deep into the sand, but they will only do so if it is suitably moist and warm - if it is too dry, too damp or too cold, egg-laying may not take place. Egg pods are roughly cylindrical in shape, about 10 cm long with a diameter of 5 mm. Between 30-100 rice grain sized eggs are laid in the lower half of the cylinder, glued together with a frothy substance which hardens soon after they are laid. More of this froth forms the upper half of the pod and extends to the surface, providing the hatching nymphs with an escape route. Each female, on reaching maturity, will lay about six pods at five or six day intervals. If many laying females are present, egg tubes need to be changed frequently. The incubation period varies

depending on temperature but, within the temperature range of 28-32 °C, takes 11-16 days. A shorter time is possible using a higher temperature, but successful hatching is reduced. Once removed to the rearing cage, tubes should be covered with a small disc of clear plastic to help retain moisture. This should be removed within a day or so of hatching. Several attempts may be needed to judge this, but it will soon become apparent what the hatching times are, if conditions are stable within the culture for consecutive hatchings.

Hoppers: Twigs placed in rearing cages should be fairly close to the light. Nymphs pass through five moults, taking about four weeks to reach the adult stage. Decreasing the heat in the latter stages of development can slow growth, but care must be exercised and the heat raised if there is an increase in the mortality rate. This ploy is useful if purchasing hoppers to grow on for feeding to stock, or when trying to hold back growth to coincide with a birth or hatching of young. It is best not to hold back the development of hoppers purchased at the first instar stage until the second instar, when they will be fully settled and feeding well.

Adults: Sexes can be determined from the fifth instar by looking closely at their abdomens. That of the male terminates in an upwardly curving point while the female abdomen has a blunt appearance. Adults become sexually mature at about four weeks of age and this is signalled by a colour change in both sexes; males showing yellow while the larger females become brown. Copulation is usually a prolonged affair.

Hygiene: This is a very important aspect of locust management for, the cleaner the conditions, the more successful a colony will thrive. Each day corpses and dried grass should be removed and a careful check kept on humidity. Apparatus should be sterilised using Philip Harris B.A.S. cleaner or similar to help reduce the risk of disease to which locusts, especially *Schistocerca*, are prone.

Humidity: The lower this is, the more likely colonies are to remain disease free. Best indicators of incorrect humidity are condensation and soft, wet or mouldy faeces. High humidity should be rectified immediately by decreasing the amount of grass fed or if this doesn't reduce humidity sufficiently, by increasing ventilation. Locusts are creatures of semi-arid regions and this must be reflected in their management.

Diet: Fresh grass should be given daily. If it is held in water-filled pots, the provision of drinking water will be unnecessary as an adequate amount of moisture will be taken during feeding. If water has to be given to hoppers then damp cotton wool in a plastic lid or a water bottle (see p.6) will suffice. On no account give water in open containers! A small amount of bran or one of the commercially available diets will also be eaten but must be kept clean. The provision of cut grass can be difficult during the winter months, in which case, wheat grown hydroponically can be used. Sown thickly on damp cotton wool, wheat will germinate in a day or so and be ready for feeding in about a week. Other greenfood such as mustard and cress can be tried. A dry artificial diet consisting of equal parts of bran, dried skimmed milk and dried grass with a little yeast can be used. This mixture is only for emergencies and water must be provided when using it. Return to feeding grass as soon as possible. Food intake decreases prior to a moult. One final point, coarse grass can cut skin quite deeply and be rather painful - cut it with scissors and protect hands with gloves!

Collecting: In warmer countries that are a natural part of the locusts range, the collection and subsequent freezing can provide an abundant supply of the creatures. This is best done when individuals start to congregate, prior to swarming. Walking through in protective clothing, and using a net to sweep through the air, a large number will be bagged. Freezing should be done as quickly as possible, chilling first to immobilise, prior to separation into daily ration amounts before completing the freezing process. Failure to chill first will result in a sticky mess.

MAYFLIES

Adult mayflies are on the wing from late April through to early June, although some may be found outside these months. Mayflies are an important part of the diet for many fish and form the models for many a salmon and trout fisherman's "flies". Larvae can be collected by searching under stones in suitable waters and adults, once on the wing, with a net. They are slow fliers and spend most of the time in vertical flight, dancing up and down, and are easily caught. Mayflies are only really viable as a livefood if living near where they can be found or if keeping few stock, where only a small number would constitute a significant addition to the diet during the relatively short period they are available.

MEALMOTHS

Moth larvae that feed on stored grains and flour are a particular pest in some areas of the world. Cereal Moth *Pyralis farinalis*, Indian Meal Moth *Plodia interpunctella*, Mediterranean Flour Moth *Anagestra kuamella* and Grain Moth *Sitotroga cerealella* are classed as pests. They are all easy to culture using basically the same method.

Housing: For culturing large jars are best and the same modifications adopted for culturing waxwoths (see p.38) should be made to the jar.

Food: Corn, wheat, whole-wheat flour, bread crumbs and bran are all eaten and a quantity of these should be placed in the bottom of the culturing jar. Eggs are laid direct into the food medium and number between 200 and 400.

Life Cycle: Egg to adult takes 6-8 weeks, and at a temperature of 26 °C culture is continuous. Corrugated paper, cloth or sacking should be made available as larvae build silken tubes from which they feed. When fully grown, larvae leave the tubes to build silken cocoons, at which point they can be collected if desired. Once emerged, adult moths last about a week before dying. As soon as the first one is found dead, feed others to stock. Eggs will have been laid in the food medium, either top up if not unclean or, as soon as moths appear, transfer some to a new container.

MORIO WORMS

Morio or Super Worms resemble large mealworms, but are a different species – Zophobas morio. They are much more active than Mealworms and have less Chitin, making them more easier to digest.

Fat	17.9%
Protein	17.4%
Calcium	124ppm
Phosphorus	2320ppm
Ca/P Ratio	0.05

Storage: Housing is similar to the Mealworms, but a tight fitting ventilated lid is required, as they are very active and can climb vertical surfaces. Morio Worms require a higher temperature of 25 C for storage and breeding.

Feeding: Again similar to the instructions for the Mealworm. Slices of carrot are supplied for moisture, as they do not form mould, but should be removed when dry.

Breeding: This is a much slower process than occurs with mealworms, often no pupae are formed or beetles produced. It has been found that a single Morio Worm is more likely to pupate when keep in a small container, similar in size to a Spice jar, in isolation. A number of these containers can be set up filled with substrate and pupation allowed to occur. After 2 – 4 weeks the pupae should transform into a

beetle. The beetles are then placed in a breeding tank with substrate and carrot for moisture. Females will lay hundreds of eggs which hatch in 1 – 2 weeks. The adult beetles are best removed after 4 weeks and placed in a fresh breeding tank for the process to repeat itself. The young Morios should be full size in 10 weeks.

MOSQUITO LARVAE

Mosquito and gnats abound near water and damp places and produce an abundance of larvae. These can be collected with a fine net. Alternatively, adults can be easily encouraged to lay by providing still water. Containers need not be too deep as larvae spend most of their time at the surface, only occasionally going deeper to swim. Plastic dustbins can be used but three-gallon buckets are adequate. These need to be filled with unchlorinated water, preferable rainwater, either from a water butt or puddles. Placed in the shade so not as to allow the water to become too hot, and left uncovered, they will soon attract adult mosquitoes. The larvae, once of a suitable size, can then be netted out and fed. If adults are required, net out some larvae and place in a jar half-filled with water. Cover with a disk of netting and adults should start to appear within several weeks.

MOTHS

As stated in the introductory chapter, the indiscriminate use of light traps should be avoided and collecting restricted to farmland and gardens only. A less intensive light attractant can be provided by a light source at night within an aviary shelter or building, usually a 40 or 60 Watt bulb. Moths can be gathered in the morning or, in the case of birds, just left there for the birds to find. Using a low wattage light bulb is only likely to attract a few moths so you can have the best of both worlds. The conventional moth trap uses special UV or mercury vapour tubes which emit light detected by most moths and can be very effective. Feeding the entire catch will soon decimate local moth populations and should not be undertaken.

Some moths are attracted at night by night-scented plants such as some types of honeysuckle and tobacco plants *Nicotichiana* and may remain in the area to be searched out the following day. Planted aviaries can contain several different types of these plants. Diurnal moths such as the migratory Silver Y can be attracted by planting lavender or can be collected with a net, if not grown in an aviary. This species occurs, on occasion, in vast numbers as a result of favourable conditions in their breeding grounds and make it to our shores, pushing further inland the more numerous they are. They rarely breed in the UK.

PACHNODA GRUBS

Pachnoda marginata or Sun Beetle is not only a useful food source, but are also kept as pets. Their life cycle is short (3 – 5 months) and easy to maintain. The grubs/larvae are ideal for feeding to larger reptiles or birds. Corvids are particularly fond of them.

Obtaining Stock: From breeders or suppliers as both adults and larvae.

Housing: Plastic containers with a ventilated lid approximately 20 x 30 x 30 cm are adequate. A peat or soil based compost is suitable with added leaf litter. The substrate is best at a minimum depth of 10 cm and kept moist at all times. Optimal temperature for breeding and pupal development is 25 C.

Diet: The developing larvae requires ripe/over ripe fruit, rotting wood and deciduous tree leaves. The adults eat most fruits, such as apple, banana, strawberry. “Beetle Jelly” is also available from specialist suppliers.

Breeding: Males can be sexed by the presence of a vertical "furrow" on the ventral surface of the abdomen. Select a pair and keep in the conditions described above and they will breed with no further help. The substrate is best left undisturbed as the eggs are delicate. The larvae can either be left with the parents or removed to a separate container.

PRAYING MANTIDS

The culture of carnivorous insects for use as livefood is impractical because of the necessity to provide a living diet for them. However, as some mantids are imported at the egg-mass (ootheca) stage, their hatching can provide a variation to a diet, even if rather unpredictable in its occurrence. Adults can also be obtained and paired. Some specimens can be of a dubious disposition and caution needs to be exercised when handling them.

Obtaining Stock: From breeders or suppliers who offer a range of species, both as adults and as ootheca. The prime consideration if purchasing ootheca is the egg quantities contained in each. This varies between species with some producing as few as twenty but several, such as *Tenodera aridifolia sinensis* from America and the common W. African mantids of the genus *Sphodromantis*, are capable of laying between 200-300 eggs in each ootheca.

Housing: Sweet jars, or similar, with a screw-top lid and furnished with a twig will be adequate. Commercially available containers, specifically for mantids, are, in my view, both too small and overly priced. Warm, slightly humid, conditions are needed for successful management. Daily removal of the lid to feed will provide a sufficient change of air, but the lid may have to be substituted with netting if a build up of condensation becomes evident - excessive, as well as insufficient, humidity is detrimental to both adults and newly hatched mantids which may drown in droplets of water.

Adult males and females must be kept separate until required for mating. Ootheca should be pinned securely through the spongy outer casing to a twig, or if feeding to reptiles, they can be placed high in a corner of the stock cage. Newly hatched nymphs can be kept together with minimal losses if well fed but as they grow, a larger incidence of cannibalism will occur.

Diet: Early stages require fruit flies, but crickets, houseflies and maggots are all needed as they develop. Much of the mantids liquid requirement is obtained from their food and only a periodical spray with a fine mister is needed.

Sexing: Easy to do, even from an early age, by counting the number of abdominal segments - females have six, males eight. A magnifying glass may be needed when sexing really young specimens.

Mating and Laying: Maturity is attained two to three weeks after the final moult. The procedure of mating is a very risky business, at least where males are concerned, for, in the majority of cases, he has his head bitten off by the female during copulation. Both sexes should be well fed before being introduced to each other. This still does not guarantee that males will survive intact but will increase their chances slightly. The sexes should be segregated once mating is over. From a single mating, females will lay a number of egg-masses which can take 8-12 weeks, sometimes longer, to hatch. Humid conditions are important, and failure to provide this will result in delayed development. Likewise, dry conditions, part way through, will encourage the ootheca to enter diapause and thus extend hatching times. Plenty of twiggy branches need to be included once the eggs hatch to allow nymphs an escape route away from each other and, also, to enable safe shedding of their skins.

Life Cycle: Nymphs reach adulthood after about six moults. Life expectancy is about a year.

QUAILS

The Japanese Quail *Coturnix japonica* was domesticated as early as the 12th century in Japan. Originally it was keprt for its song but, as time passed, egg and meat production increased for human consumption and it is now considered a delicacy in many countries. A more recent use has been for animal feed and they are either bred specifically for this purpose or old breeding birds are culled and used. They are a food favoured for many Raptors and are a more balanced diet than the usual day old poultry chicks, although cost may be prohibitive to other than the most serious keeper.

There is little doubt that even the odd one now and again will prove beneficial. Breeding quail on an amateur scale is possible but the initial set-up costs are high. Breeding stock is relatively cheap as are the running costs but the provision of suitable accommodation and the purchase of incubator and rearing equipment can be expensive. Techniques need to be learned and adapted to match the situation.

Purchase of Stock: Adverts generally appear in Cage and Aviary Birds magazine or, more specifically in journals that cover the poultry and farming industries. Newsagents should stock most titles. Birds may also be available through pet shops and bird dealers.

Housing: Suitable units can be purchased but are expensive and unless the possibility of rearing enough to sell to recoup some of the costs, it is best to make your own. The units described by Robbins (1983) for ornamental quail are adequate for Japanese Quail. Equally, units can be custom made to fit in with any shed dimensions. The larger rodent boxes can be adapted for a male and three females but servicing them can be tricky. A unit for four males and 10 females is described in the UFAW handbook as follows:- A box is made of 12 mm plywood with the dimensions 50 cm wide x 70 cm long and 30 cm high. Base, both sides and back are solid while the front and removable lid is wire on a wooden frame. Food and water can be given, adapting the swivel feed and water system for parrots. The deep litter system can be used if kept in a building. Primary flight feathers can be clipped to prevent scalping. Some cover should be provided to help cut down the risk of fighting. Wood shavings can be used on the base of any accommodation, as can sharp sand.

Feeding: Fresh water can be given in dishes, cage bird plastic drinkers or by adapting one of the nipple drinking systems available for small mammals. Adult birds need to be fed a mixture of seed and a quail diet is available from Haiths (see suppliers). For a more regimented breeding diet, a partridge breeder pellet available from gamefeed suppliers is ideal. Grit must be offered at all times, especially to breeding females. A liquid calcium concentrate can also be added to their water at this time, as their egg production is little short of phenomenal once they start.

Breeding: It is unlikely that females will be induced to incubate their own eggs in the confines of a box-cage. This process, for mass production, wouldn't be required anyway, as it is not conducive to continuous laying. Collected eggs need to be stored large end up or on their sides and turned an odd number of times each day to avoid contents sticking to the inside of the shell. Keep at around 18 °C with 70% relative high humidity. The temperature of the incubator for setting eggs needs to be 37.5 °C with a 55% relative high humidity.

Eggs must be cleaned in warm water (not cool) to which is added an egg cleaner, to remove surface dirt and to disinfect them. Eggs take between 16-17, occasionally 18 days, to hatch and should be removed at 14-15 days to a hatcher where increased humidity should be given to facilitate hatching. On hatching leave chicks to dry then transfer to a rearing unit. Heat needs to be provided and for the first week this should be around 36 °C, decreasing 2 °C each week until fully feathered at around four weeks. Electric hens or infrared bulbs placed 40-50 cm from ground level can be used. A good layer of floor covering is essential and if deep enough should need little cleaning during the life of the hatch. Sand and wood shavings are ideal and during the first week, sacking can be placed on top of this to provide extra grip. Partridge and quail crumbs can be offered initially, progressing to mini pellets as the chicks grow. Full size is attained after four or five weeks and egg laying can commence a week later. The above is just a brief summary of what is required and the management of quail is more fully documented in Robbins

and the UFAW Handbook, either of which should be consulted when contemplating the keeping and breeding of quail.

RABBITS

For a small supply, perhaps the best method is to use the colony system where a buck is kept with a number of females. Even where two or more groups are maintained, there is the need for only one buck, transferring him periodically between the groups. Tests have shown bucks to be both very promiscuous and also extremely fertile with it. One such test witnessed 37 matings in three separate forty-five minute spells over a six hour period - and all produced good sized litters! Normal groups should consist of one buck to ten or twelve does. If the buck is introduced to a group of females, litters will be synchronised to within a day or two

Frozen rabbit can be purchased quite cheaply during certain times of the year, either directly from a butcher or via a supplier of frozen animal foods.

Obtaining Stock: From pet shops or direct from a breeder if specific types are required. Smaller breeds, such as Dutch Dwarfs are ideal, as they require less space.

Housing: Runs can be made from a variety of materials, with much depending on cost. A block of cages, each housing a doe in readiness for the buck can be used if space is limited. If space isn't a problem, runs 2 m square by ½ m high can be used. These should have a netting cover and adequate shelter for the number of rabbits to be kept. If pens are not moveable, floors need to be concrete, and slightly sloping so as to allow excess urine to drain and to facilitate easy cleaning. Ample hay or straw needs to be provided as bedding and topped up periodically for it will also be eaten.

Food: Many types of commercial food are available and as with most forms of stock, the better the food consumed, the better the results, especially with lactating does - litters will have better survival rates and grow much faster. Different diets are available for the various stages of development and should be obtained from feed merchants. A variety of fruit, vegetables and greenfood is also needed - apples, lettuce, tomato, carrot, cabbage, grass, chickweed and dandelion leaves are all welcomed.

Breeding: After a gestation period of just over four weeks, weaning can take place as early as a month but continued growth may be slow. Six to eight weeks will still provide steady growth, as the young are much less dependent on milk by that age. After weaning, young can be held in groups of up to twenty if area permits until around three months old. By then, female groups should be in place with retained males separated, as they can become extremely aggressive towards each other. Does of smaller breeds can be mated at 3-4 months while those of larger breeds, a month or so later - do not be tempted to breed too early!

SLUGS

Over twenty species of slugs are found in the UK ranging in size from about 7.5 cm down to 2 cm. A few species will take slugs and it is well worth trying, as they are a food readily available during most of the year. Small ducks are very partial to them, as are some amphibians.

Collecting: Various methods can be employed ranging from baits to traps but the best way by far is to search in the garden after dark. With a torch and a suitable container, all that is likely to be needed for a days feeding will soon be captured. They can be caught by placing the container on its side and flicking them into it using a stick. They can then be put inside an enclosure and left to crawl out on their own. If possible, use containers that are disposable or able to withstand a good wash, as they become very slimy.

The keeping of slugs for any length of time is not necessary, as most locations which produce reasonable quantities are likely to be able to sustain such numbers. However, in hot weather, an area will need to be kept moist in order to encourage the slugs to move about.

SNAILS

This group falls into two categories, those that are found on land and those occuring in still water. Both add variety to diets and are easily collected.

LAND SNAILS

Culturing these useful molluscs is possible, but, in terms of the numbers reared in relation to the space and effort needed, it is not really a practical proposition for the amateur. Collecting the three recommended species can be worthwhile for, quite often, numbers in excess of those required for immediate feeding to stock can be obtained in a very short space of time. Surplus can be kept for later use.

Collecting: Only three common species, the Garden *Helix aspersa*, White-lipped *Cepaea hortensis* and Brown-lipped Snail *C. nemoralis* should be collected. All three are garden pests in moist regions. Other species should he avoided for a variety of reasons, not least being the extreme scarcity of some species. Collecting the recommended species usually presents no problem in areas where they occur. Leaf litter, crevices in walls and rock-piles are all good sites. Ivy-covered stone walls with associated verge vegetation, especially Umbellifers, are most productive. Early morning or late afternoon are good times for collecting, particularly after rain but by far the most productive period is likely to be after dark.

Housing: A wide variety of containers can be used but covered plastic aquariums or seed propagators are the most suitable. Ventilation is of prime importance with perforated zinc or fine wire mesh being the most suitable covering for apertures; one must be low, the other high, in order to allow a continuous passage of air. Snails produce a profusion of slimy mucus and all materials and non-disposable containers must be able to withstand a good wash. Conditions must be very moist but not so damp as to allow standing water. Drainage holes drilled or punched through the base of the container will act as an additional safeguard against the build up of standing water. Soil should be used as a floor covering. Into this a variety of weeds and grasses can be planted. Cleaning, which must be done frequently involves the removal of all snails and the discarding of contents followed by a thorough cleaning prior to refurbishing and stocking.

Diet: A wide variety of food is eaten. Lettuce, dandelion, apple and root vegetables are avidly taken. A separate supply of water is not required if containers are kept moist. If keeping for lengthy periods, a piece of cuttlefish or eggshell must be made available to provide calcium, otherwise they start to rasp each others shells.

AQUATIC SNAILS

A number of species are found in the UK but only the Giant Pond Snail *Lymnaea stagnalis* is worth considering. Numbers can be collected either by hand in shallow water or by sweeping vegetation with a net. They can be kept in pond water with a little aquatic vegetation or lettuce as food.

Housing: The most suitable containers are plastic aquariums and the larger these are the better. If a continuous year-round supply is needed, a number can be set up in a place where they will not freeze in winter.

Feeding: To achieve best results, set up tanks well in advance to allow algae to establish on the bottom and sides of tank as well as any furniture placed inside containers. Snails will graze on the algae but this will become exhausted as the colony grows and so will need to be supplemented with lettuce.

Breeding: When adults are mature, eggs will start to appear as a gelatinous masses attached to most surfaces, including glass, which, apart from anything else, allows a very close view of development. Growth is faster in summer than in winter but growth rates can be increased at this time if water is warmed slightly with an aquarium heater and food kept plentiful.

SPIDERS

It is unfortunate that none of the numerous species of Arachnids lend themselves to culture on a worthwhile scale. They are one of the most useful of livefoods, especially for the keeping and breeding of insectivorous and nectar-feeding birds.

Collecting: The chief advantage spiders have over most other forms of livefood collected from the wild is that they are still available late into the autumn, well beyond the peak of wild invertebrate abundance and can, therefore, be quite a valuable addition to the diet at that time.

Spiders are present in most habitats but are more abundant, both in terms of species and population densities where there is a proliferation of other invertebrate species upon which they prey. Nettles are an ideal place to search for them and they are best collected by sweeping a net through the tops of the plants. This method has the added bonus of bagging a variety of other insects. Sweeping verges and tall meadow grass also proves worthwhile, as does ivy, which produces a number of the large *Araneus diadematus*.

In some localities, ground dwelling *Pardosa* are numerous and are often seen scuttling across lawns or waste ground. Catching can be effected with a jar, a net, or even by hand. Any spiders caught should not be kept together for prolonged periods for they tend to be cannibalistic and numbers are soon reduced. If intended for release into an aviary, foliage will ensure ample hiding places allowing them to keep out of each other's way for long enough to be of benefit. Once birds become accustomed to this, they soon learn to search for the spiders when released.

Although impractical to culture, the removal of egg-masses can produce an abundance of tiny spiderlings in spring. Egg-masses, located in autumn and winter, can be left *in-situ* until the following spring when they can be gently removed to a container for hatching. Resultant spiderlings should be fed to stock immediately. Corners of windows, beneath shelves and inside old buildings are all likely hunting places for egg-masses. If a note is made of all those found, then, come spring, quite a number will have been located.

SPRINGTAILS

Springtails of the order *Collembola* are about as small and useful as non-aquatic livefood can be. It is well worth the effort collecting, as small newly hatched creatures, which prove difficult to establish on even the smallest of other livefoods will usually take them. They are also a most useful item for small geckos and poison-arrow frogs. Most species are characterised by their ability to use their tails to spring into the air. This carries them a considerable distance in relation to their body size and acts as a defensive strategy.

Collecting: Simply gathering damp leaves will provide a number but with a sustained search, a location should be found where they are abundant.

Breeding: If access to an area of damp leaves is possible, the need to set up for breeding is unnecessary. If not, a small area in the corner of the garden, in shade, where a small piles of leaves can be left will suffice. Alternatively, a container with fine drainage holes in the bottom will be adequate. Leaves of deciduous trees can be used and these need only to be heaped in the chosen site or placed loosely in a container, and kept moist, as these creatures do not favour dry conditions. The decaying matter will provide an abundance of food for these and other creatures that appear in the culture.

Feeding to Stock: Either breeding or collecting from the wild will need the same technique before feeding to stock, unless leaves are to be placed directly into enclosures. A large funnel, fine chicken wire or welded mesh and a large jar are needed, plus an overhead heat source. The larger the funnel used the better. Into this place a circle of the mesh, allowing space between it and the spout entrance. If the storage jar is deep enough the entire spout can be left, but needs to be cut off if it touches the bottom so as to allow the insects to drop through. A quantity of leaves can then be placed in the funnel and the whole placed under a modest heat source such as a 40 or 60 Watt light bulb. As the leaves dry, the springtails and other creatures will travel deeper in search of moisture until they fall through to the jar. A small quantity of damp leaves or tissue paper needs to be placed in the jar to allow the creatures to not only hide but to keep moist until fed.

STICK INSECTS

The familiar Indian Stick Insect *Carausius morosus* has been a popular subject with laboratories and schools since the early 19th century. However, during the last three decades or so there has been an upsurge of interest in other members of this large family, resulting in the formation of a study group whose aim is to investigate various aspects of husbandry and behaviour in other available species. The pooling of knowledge on the various species has facilitated approximately forty species being established in culture. While many are sufficiently established to provide stock for those interested, it remains doubtful if many of the species could be bred in such numbers as to be a viable source of livefood. Species such as the Spiny *Extatosoma tiaratum* are rather large creatures and would, undoubtedly, provide a substantial meal for small carnivores. However, the trouble involved in rearing a few of the larger types must be weighed against the ease of rearing large numbers of some of the smaller species.

Another consideration is that many stick insects emit an odour that is thought to act as a defence mechanism. In some it is barely detectable but, in *Anisomorpha buprestoides*, there is the capability for producing an acrid-smelling spray. Even amongst devotees, this species is regarded as thoroughly obnoxious and to be handled with extreme care. Males of some stick insects, such as *Eurycantha calcarata*, have formidable leg armoury and blood-letting is not unknown to keepers of this species! For the purpose of these notes, details relate to the Indian Stick Insect because its requirements are well known and it is accepted by a wide range of species. For those wishing to experiment with other phasmids, detailed culture notes covering a further 15 species will be found in Brock (1992).

Obtaining Stock: All ages are generally available from suppliers but, if a breeder can be found locally, they may be more than willing to give away surplus adults, nymphs or eggs, for once established the high productive rate of stick insects often prove an embarrassment. Suppliers of reptiles and amphibians to the trade sometimes dabble with invertebrates but the best source is likely to be the Phasmid Study Group, "Papillon", 40 Thorndike Road, Slough, Berkshire, SL2 1SR who can advise on all things phasmid.

Housing: Many different types of container are suitable as accommodation but several points need to be taken into consideration. Developing young must have adequate height to avoid being disfigured whilst their bodies are still soft following skin shedding, and adults require a reasonable amount of room and a constant supply of food if limbs are not to be lost through cannibalism. Fish tanks are suitable containers providing they are sealed with a tight fitting lid which can be effected by means of fine netting attached to a wooden frame or held in place by a loop of elastic around the rim of the aquarium. Large glass jars can also be used for small populations but are not really practical on account of their narrow access holes, which require the old food material to be taken out before the insects are removed. A sheet of white paper is useful, for any stick insects which fall will play "doggo" and be easily visible upon it. Rigid plastic sheeting joined with aquarists silicone sealant is a relatively cheap means of housing, but almost any material could be used, the only criterion that need be considered is size - the bigger the better!

Temperature: Not as critical a factor as it is with most cultured insects, though warmer conditions shorten the life cycle. A minimum winter temperature of 20 °C is adequate.

Diet: Stick insects are very catholic in their eating habits, with privet and ivy readily taken. Bramble, the first choice for the majority of phasmids in culture, is taken by *C. morosus* with great reluctance, but is preferred because of the possible retention by the insects of toxic properties contained in both ivy and privet. That being said, I am not aware of any problems having arisen by anyone using these food plants and have yet to come across suggestions in entomological literature that this is the case. It is perhaps best to offer as many types of foodplant as possible. Cultivated blackberries are now available from garden centres and several thornless varieties exist. They can be planted out or potted into as large a pot as possible and placed in the shade. As winter approaches the pot can be brought into a greenhouse or sheltered area which should ensure some foliage is available well into the winter.

It must be said that a liking is shown for many houseplants, which are usually attacked when the insects escape. Rubber plants, various succulents and the spider plant *Chlorophytum* are all taken with relish and, in actual fact, several authors recommend the latter as a winter stand-by. Cut food plants should have their stems re-cut prior to feeding and be placed in water to keep them fresh longer. The top of any water containers should be plugged with cotton wool to ensure that no insects fall in and drown.

As winter approaches, fresh bramble becomes increasingly difficult to find, but only in prolonged spells of really harsh weather is it likely to be impossible to locate. In such cases, small pieces of stem can be blended with a little sugar and water into a mushy paste. Acceptance is variable and most individuals will have to be placed upon the mixture. Decreasing the heat will slow feeding but any breaks from normal conditions should be kept short. During winter it is advisable to trim the brown curled edges from bramble leaves to allow easy access to fresh areas. Some moisture will be taken in through their food and a light spray with a mister in the evening will encourage the stick insects to drink from the droplets.

Breeding: Parthenogenic - populations comprise almost entirely of females with the occurrence of males given as low as one in a thousand by some authors. Two systems of breeding can be employed, both of which will be successful. The simplest is to contain the entire colony, in all its development stages, in one large unit. The other method is to keep the breeding stock in one cage, removing eggs for hatching and rearing on. Eggs can be placed in a separate container and hatched at room temperature, placed in the airing cupboard or control hatched in an incubator at around 22 °C. Hatch rates are good even at lower temperatures but take longer, and, even eggs set at the same time can have a staggered hatch. Keepers of reptiles and amphibians can scatter eggs on the vivarium floor or placed in a dish and left to hatch.

Life Cycle: Once mature, females drop eggs at the rate of 5-9 per night and these can take as long as 6-7 months to develop. Nymphs take a further four months and five moults before reaching adulthood. Life expectancy of an adult is about nine months, of which two-thirds is spent at peak egg production.

Footnote: Of others available, perhaps the Pink-winged Stick Insect *Sipyloides sipylus* is another worth attempting to breed. It is an altogether larger parthenogenic species. Life cycle is shorter but the eggs are stuck to a rough surface instead of being dropped and, for this reason, rough bark must be offered. Food is bramble and hawthorn.

TADPOLES

The gelatinous mass of spawn deposited by many frogs and toads is eaten rarely but the developing tadpoles are taken by a variety of species, especially aquatic carnivores. It is worth experimenting with both the spawn and tadpoles to see which species will consume them. Spawn collected in early spring can be kept in buckets, washing-up bowls or plastic aquariums for the two to three weeks it takes to hatch. They should be kept in either the water in which they were found or

rainwater and, where possible, kept in the shade to prevent overheating. An occassional stir will help keep the water oxygenated.

Newly emerged tadpoles feed on algae, debris and dead animal matter and, if not feeding to stock within a couple of days, food must be provided in the form of water plants, algae covered rocks, lettuce and other material on which they can graze. They will also nibble at pieces of liver and mincemeat.

TERMITES

Termites, sometimes called white ants, abound in various parts of the world, most usually where the climate is warm. None are found naturally in the UK although one species was discovered in 1999, established in a house on the south coast. All termites are useful items of livefood and in some countries, are used quite extensively for the many forms of animals which will eat them. Termite culture is difficult and so collection is a preferred option. For the purpose of these notes, termites world-wide are divided loosely into four categories - damp wood dwellers, dry wood dwellers, subterranean dwellers and mound builders.

Damp wood dwellers

Damp, rotting logs, usually in the vicinity of running water is the favoured site to search for these insects in western North America. As with all other termites, entrance holes are sealed so the only way to be sure of their presence is to break into the log. Once found, pieces of log, as large as possible, should be collected and quickly transferred to containers for storage, for which purpose dustbins, water butts and 44-gallon drums can be used. Placed in shade in a cool situation, the container should be covered with a piece of damp sacking to maintain both moisture and humidity. If kept for any length of time, a periodic spraying will help replace any moisture loss. No additional food need be given, as the rotting wood will provide ample nourishment. To feed to stock, break open pieces of wood, and shake the loose termites into a bowl. Alternatively, for species which are able to forage for them, break the wood into suitably sized chunks that they are likely to be able to deal with, periodically breaking further to expose more termites.

Dry wood dwellers

These attack sound, untreated timber of wooden structures and are not usually a practical subject for collection unless a building, due for demolition, is found which contains termites. Treat the collected wood, along with some other pieces of timber as for damp wood termites except in this case there is no need to spray with water.

Subterranean dwellers

These termites live underground in wood buried by soil, they do not make a good stored livefood. Best to dig up and feed to livestock straight away.

Mound dwellers

Characteristic of certain parts of Australasia, Africa, and, South and Central America, mounds take on two forms, the boreal, usually small structures seen in the more forested areas and the terrestrial, sometimes massive structures found in semi-arid and lightly-wooded regions. Collecting these simply involves breaking pieces off the mound, usually in the morning, when termites are near the surface. Remaining termites will repair damage if it is not too severe. Keeping and feeding to stock is the same as for damp wood dwelling termites.

TUBIFEX

Tubifex worms are creatures of organically polluted waters, feeding on the nutrient rich sludge that is created in such areas. They are a typical indicator of pollution and as such are more abundant in areas that attract organic debris. They spend most of their time anchored to the sludge with the upper half of their body waving in the current in search of food. Large numbers live in the filter beds of sewerage works and even in relatively clean water, modest quantities can be found along muddy banks. If a suitable site is found, scraping away the top 5-8 cm of sludge, placing in a sieve and swishing it about in water will separate the worms. Before feeding worms to stock, they need to be cleaned for 24-48 hours in clean water under a dripping tap. They can be kept alive for several weeks if retained in jars of cool water, which must be cleaned every couple of days or so.

Culturing: Can prove difficult, but perhaps the best chance is to be had by placing 5-8 cm of mud and sludge in a large container (minimum size would be a washing-up bowl) and covering with a similar depth of rainwater. Periodically, add small amounts of animal manure, leaves, lettuce, cabbage, and bread or similar, with just enough to create a little, almost continuous state of decomposition within the culture, adding as and when needed.

Feeding to Stock: For fish, in specially purchased feeders, which allow only a few worms to be released at a time. For other aquatic feeders, place the required amount directly into water, or in a dish containing water.

VINEGAR EELWORMS

Known by alternative names such as Micro-eel, Vinegar Eel and Acetic Micro-eel, *Turbatrix aceti* is simplicity itself to culture and large numbers can be bred with little trouble. Individually, they are barely visible to the naked eye but, in a well advanced culture, simply holding the container up to a light will reveal just how prolific they can be. Perhaps explaining their prolific nature, is their tolerance of a wide range of temperatures and pH levels.

Obtaining Stock: Purchasing from a breeder is recommended. The eelworms will arrive in a small quantity of culture medium and it is best to enquire of the supplier, in advance, what is being used.

Culturing: On arrival, and if no instructions are provided, the contents should be added to a pint of cider vinegar held in a bottle, jar, or an open dish, and left at room temperature. Several slices of fresh apple can be floated in the vinegar. Within a short period, the culture will be advanced enough to remove sufficient both for feeding to stock or for sub-culturing. This is achieved simply by using a meat baster or ladle. Vinegar Eelworms can be added to new jars or strained through muslin or a very fine sieve, allowing the vinegar to drain back into the old culture. The medium can be used several times before becoming exhausted. Worms dying or showing signs of slow development are the best indication that new cultures need to be started. Old cultures can be drained, some retained for new cultures and the rest fed to stock. Before feeding to stock, wash thoroughly in clean water and give only enough, directly into the aquarium or a shallow dish of water, that will be eaten in a short time otherwise they will soon perish.

WASPS

The abundance of wasps (*Vespa* sp.) in season is very evident if stock is kept which consumes any sweetened liquid. These pests trouble lorikeets in particular but some species are well able to cope with them. The sweetened liquid that attracts them to nectar feeders can be used with equal success elsewhere. A simple mixture of honey and water will suffice, as will a spoonful of jam mixed with water. Cover container with mesh to ensure birds do not gain access and drown. Chopped fruit will also attract wasps, along with flies, as will the attractant produced by Barratines Enviromnental Health.

Smelling and looking very much like liquid mango chutney, this is effectiveness personified but extra care is needed to ensure wasps do not imbibe the liquid if they are taken by birds.

WAXMOTHS

Occasionally called honey moths, waxmoths can become the scourge of bee-keepers, their larvae attacking the honeycomb to such an extent that considerable damage is done. Until recently, they proved difficult to rear but are now relatively easy to culture since the advent of artificial diets. Several species are available with *Galleria melonella*, the Greater Waxmoth, the one most likely to be encountered.

Health Warning: Although rarely recorded, an allergic reaction can occur when handling moths. The tiny wing scales cause this and, unless protective measures are taken, their culture should be abandoned. Symptoms include skin irritation and sneezing.

Obtaining Stock: Purchase larvae from a commercial livefood supplier.

Housing: Plastic sweet jars are ideal after slight modification. The two main concerns are the provision of ventilation to the culture and adequate moisture for the adults. Both are easily overcome by cutting a hole in the lid large enough to snugly accept a metal tea strainer or fine flour sieve. It is imperative that metal is used. Glued in place, either will prove ideal and adequate ventilation is provided. Also, when moths are present, a wad of damp cotton wool can be placed in the cup to provide the necessary moisture.

Containers need to be kept dark and this can best be done in a dark place away from light - but where light is readily accessible to allow for inspection! Another way, although much less satisfactory in terms of viewing the culture when needed, is to darken the container with black paint.

Diet: Prepared mixtures can be purchased, through some but not all breeders, at the same time as cultures are ordered and it is advisable to stick to such mixtures for the next generation, at least, before experimenting with home-made diets. Amongst successful mixtures are (a) Farex, yeast, glycerine and honey in the ratio, by weight, 2:1:1:1. and (b) Farex (standard box), 250 g wheatgerm, l00 ml glycerine, 375 g honey and a teaspoonful of yeast. All ingredients, in both preparations should be thoroughly mixed. Warming the honey will help make this task easier, being careful not to overheat as it can become dangerous, especially if using crystallised honey as the base will melt, causing pressure to build up under the cooler upper layer hence, stir well! Also, the honey can stick to hands whilst mixing and cause severe skin burns if hot.

Culturing: Waxmoths are lovers of heat and temperatures around 30 °C are needed for optimum success. Place the food medium in a sweet jar and add 40-50 larvae or pupae. When purchased, enough larvae or pupae to begin a culture usually arrive in sawdust or a role of corrugated paper, which should be stood upright and pressed into the food in the jar. On hatching, a wad of damp cotton wool needs to be placed in the ventilation cup - moisture for developing larvae is obtained from the honey and glycerine contained in their diet. To provide an adequate supply for stock, at least six cultures should be maintained.

If properly managed, the first culture should provide sufficient numbers of larvae to enable as many other cultures to be undertaken as are required. The simplest way to do this is to allow the first generation of larvae to develop until they are quite large and then tip them out onto a tray. Allowing for fatalities, separate about fifty and introduce into a fresh batch of food which has an upright roll of corrugated cardboard standing in it. This will provide enough food for the present and next generation but the corrugated cardboard needs to be changed after each hatching of moths. Surplus can be fed to stock or allowed to develop into moths. Some lizards and birds will welcome these flying insects into their diet and the waxmoth will provide variety as well as encouraging exercise.

Life Cycle: Mating takes place within a day of emergence as adults. During her life-span, a female waxmoth will lay between 300-1000 eggs which soon hatch. Four to five weeks are spent as larvae and a further week or so as pupae. Moths live for only ten days, probably much less if kept at high temperatures. At the first signs of fatality in the moths, the rest can be fed to stock but the corrugated cardboard should be retained and placed in a separate container for late hatchlings.

WHITEFLIES

Whiteflies attack garden and houseplants and can often become quite a serious problem if left unchecked. Reproduction is quite prodigious, often to the point where an infestation seems to appear overnight. The Greenhouse Whitefly *Trialeurodes vaporariorum* is an insect which has provided gardeners with a headache since it was first introduced into the UK. Little or no use is made of this minute creature as a livefood but, for those keeping certain reptiles and carnivorous insects, experimentation, especially with new hatchlings, is worthwhile.

Obtaining Stock: Obtaining plants already infested is the best way, but acquisition of plant species known to be susceptible is usually enough. An attack will sooner or later become apparent. Enquiries at a garden centre may prove worthwhile but ensure that spraying with toxic chemicals has not been carried out beforehand on any plants in close proximity. Since whitefly mainly inhabit the underside of leaves, a light infestation may not be readily apparent but once becoming heavy, a certain number of individuals will be very much in evidence, especially when the plant is disturbed.

Housing: The chief point to consider is the host plant. A wide range of plants is attacked and it is sensible to select species that are easy to obtain and propagate. Lantana and abutilon can become heavily infested but tomato, pelargonium and fuchsia, preferably the latter, are the best species to use. For obvious reasons, propagation is best carried out in isolation, preferably in a part of the garden where there is little chance of whitefly spreading.

Cloches are ideal but cheaper housing can be produced using wood and polythene sheeting. Four 2.5 cm x 2.5 cm uprights of suitable length are pushed into the ground to form a square large enough to take the host plant(s). Wrap polythene sheeting around the uprights and hold in place with drawing pins or adhesive-backed Velcro strips. Likewise, a piece of plastic, cut to allow a slight overhang on each side, can be pinned over the top of the uprights. Drawing pins allow for easy removal of the plastic in hot weather for ventilation. In early autumn, bubble plastic can be substituted which will provide extra insulation, thus extending the period over which whitefly can be cultured, as can transferring to a small, cheap lean-to type greenhouse. The cost of the latter may seem prohibitive but if species will take these insects it is worth the expense, taking into account that the cost of the stock will ultimately to exceed greatly the cost of the greenhouse.

Diet: Whiteflies derive all their nutrient requirements from feeding on the sap of their host plant. Heavy infestations damage vegetation, so an adequate supply of plants must be kept to allow the damaged ones to recuperate.

Life Cycle: In the region of 200 eggs are laid which hatch after about ten days. Larvae appear as scale-like creatures on the underside of leaves. A complete cycle takes four weeks at 20 °C and is shortened by a week at 25 °C.

Feeding to Stock: The simplest method is to disturb an infested plant and, with a net or dry jar, sweep over it. Alternatively, an infested leaf can be removed. If a small potted plant, which has been used for culturing, is placed inside the stock cage then any remaining whitefly upon it will survive for later consumption by stock. Once cleared of whitefly, plants can be removed or replaced to await the hatching of any eggs that have been laid on the plant.

WHITEWORMS

The familiar term of whiteworm is applied to members of the genus *Enchytraeus* that encompasses the few species in culture. The techniques below are applicable to most species likely to be encountered. Whiteworms are creatures of the soil and are their abundance is governed by the nutritional composition of different soils.

Obtaining Stock: Collection from the wild is feasible but not really a practical exercise. Purchasing from breeders is the best means, especially as starter cultures are reasonably priced.

Housing: A variety of shallow containers are suitable but plastic washing-up bowls or cat litter trays are ideal for they will not rot. Three or more cultures should be kept simultaneously in order to provide a continuous supply. Fill the containers two-thirds full with peat or one of the peat-based bulb potting composts, purchased from garden centres. The mix should be damp and crumbly. Never allow it to dry out or become too saturated. Moisture can be retained by placing a sheet of glass or clear plastic over the container – this will also serve to assist in keeping predators at bay. The peat mix may become stale after a year or so and should be changed, staggering the process when a number of cultures are maintained. Cultures should be kept cool at around 16 °C and be located away from direct sunlight - high temperatures can be fatal to them. Good places for cultures are spare bedrooms, garden sheds or cellars, especially the latter for they maintain a fairly constant temperature. Regular checks should be made on the progress of cultures and within a month they should be ready for use.

Diet: A number of items can be offered. Bread and milk, oatmeal, mashed potato, moistened dog biscuit and table scraps will all be eaten. To feed, scoop out several holes in the peat and fill with food, ensuring that it is then completely covered by the peat again. Failure to do this will encourage mould. When starting new cultures, add a little of the used food, as this will contain worms and eggs. Food turning sour is one of the major causes of failed cultures, feeding little and often will help alleviate this problem.

Reproduction: Similar to earthworms in that they have the ability of both sexes. Two worms lying next to each other, head to toe, effect cross-fertilisation. After the interchange of sperm they separate. Eggs are spawned in transparent cocoons and are clearly visible in cultures.

Feeding To Stock: Washing proves the most satisfactory method of cleaning. If a quantity of food, with worms in it, is placed in a sieve under a running tap, most of the food will be removed. In productive colonies, whiteworms should be easily removed with very little food adhering to them. For fish, whiteworms can be placed in a special floating holder which allows them to wriggle through, but for reptiles and birds, place them on damp sand.

WOODLICE

In the region of forty species of woodlice are to be found in Britain but only three are over 15 mm in length. It is with these that most people are familiar. Two species, *Oniscus asellus* and *Porcellio scaber*, are similar in appearance and are the ones most likely to be encountered in the garden. Neither of these roll into a ball when disturbed, unlike the Pill Bug *Armadillidium vulgare*, the only other species likely to be encountered.

Woodlice have a protracted life cycle with young taking between three months and two years to mature, depending on species and environmental conditions. After mating, fertilised eggs are transferred, by the female, to a liquid-filled brood pouch on her underside. There the eggs remain for 3-5 weeks before hatching into miniature replicas of their parents. The protracted life cycle, coupled with the fact that very few species take them when offered, make woodlice unsuitable subjects for culture. Collection is worthwhile if you do happen to have a species which will consume them for woodlice require very little trouble to care for and in the right locality, can be very abundant.

Collecting: Being nocturnal creatures, they tend to hide in damp places during daylight hours. Places to search are under fallen, semi-rotted trees, loose bark, stones, plant pots etc. A trap can be made by boring holes in a potato. Plug the end of each hole with a piece of potato and leave for several days on the ground in a wooded area covered with leaves. The woodlice can then be shaken out into a container and the traps reset. Stacks of firewood are particularly productive.
Housing: Outside housing is best for these hardy creatures. A large plastic drum with a tight fitting lid is ideal. Ventilation can be provided by drilling holes in the lid or cutting out a section and covering the aperture with wire gauze. As a base, moist peat and dead birch leaves are sufficient. On top of this, place a quantity of rotted wood for shelter. Moisture is an important factor in woodlice maintenance and they must not be allowed to become desiccated, as this will kill them. A light spray given periodically will be of benefit but excessive moisture should be avoided. Holes drilled in the base will help, as will covering the top with a sheet of glass or Perspex, which serves the dual purpose of maintaining humidity within the culture whilst keeping water from entering ventilated areas. Very cool temperatures can be withstood but, in prolonged cold snaps, temporarily housing them in a greenhouse or shed is wise. Woodlice may also be kept outside in a hole dug in moist, shaded ground. This should have minimum dimensions of 50 cm x 50 cm x 50 cm and be almost filled with leaf litter and rotted wood. A solid cover is advisable in very wet weather as is some form of insulated cover in prolonged periods of cold in the winter months.

Diet: Decaying plant material forms the bulk of their diet but they will also nibble young seedlings and dead animal matter. A variety of dead plant matter can be offered but if kept as recommended, the leaves and rotted wood will prove adequate for large numbers. Additional leaves, of varying species and decomposition, can be given periodically, as can small quantities of apple, cress, lettuce, potato or bean sprouts.

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GLOSSARY OF TERMS

Arachnids: Of the spider family.
Blown: Tainted with fly eggs.
Brood Pouch: Protective area for safe development of young.
Cast: Small mounds of soil, usually the work of worms.
Chrysalis: The pupal or third stage of development.
Culturing: The breeding of species under artificially controlled conditions.
Damping Down: Slight wetting to provide moisture, either to settle dust or to provide droplets for drinking.
Desiccate: To dry out.
Diapause: A temporary cessation in development that can be brought on, or broken, by factors such as changes in temperature and light.
Faeces: Droppings.
Gestation Period: Time between mating and birth.
Gregarious: Numerous individuals living together as a group.
Hermaphrodite: Individuals having the reproductive capabilities of both sexes.
Hoppers: Young locusts.
Host: A species that provides a living for others.
Host Specific: A particular species, which lives in, or feeds on, one particular plant or animal.
Husbandry: Technique of captive animal management.
Incomplete Metamorphosis: Life cycle of insects where the second and third stages (larvae and pupae) are replaced by a single growth stage. Eggs hatch to produce miniature replicas of adults. These progress through a series of moults until the adult stage is reached.
Instars: Growth stages of species such as locusts and crickets.
Invertebrates: Creatures lacking a backbone.
Larvae: Second stage of metamorphosis - caterpillar, grub etc.
Metamorphosis: Development of insects through four stages egg, larvae, pupae and imago (adult).
Molluscs: Soft-bodied, usually hard-shelled invertebrates.
Mould Inhibitor: Substance to prevent mould growth.
Nocturnal Lepidoptera: Night-flying moths.
Nymphs: Growth stages, usually the early ones, in species such as crickets.
Omnivorous: Animals which eat a variety of different food types, such as vegetables, animal flesh, grains etc.
Oviposition Vessel: Container provided for egg-laying.
Parthenogenic: Having the sexual capacity of both sexes.
pH Level: Degree of acidity or alkalinity of a particular substance.
Phasmids: Stick insects and related species.
Photoperiod: Natural balance of daylight and darkness.
Pooter: Item of equipment, using the same principals as an eyedropper, valuable for isolating small creatures.
Pupae: Third stage of invertebrate development.
Subterranean: Living below ground.
Terminal Abdominal Segment: Last division of abdomen.
Umbellifers: Large, diverse family of plants containing species such as hogweed, cow parsley and wild carrot.
Waxbills: Family of African seed-eating birds, which are insectivorous when feeding young.