Culture of crickets: A food for amphibians and reptiles

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Most postmetamorphic ranids and many other amphibians as well as reptiles and birds used in biological research, teaching and display are currently maintained on living food (Hirschfeld et al., 1970; Nace, 1968; Nace et al., 1974; Culley et al., 1978). This situation necessitates the purchase or culture of suitable forage. One commonly used species is the domestic cricket, Acheta domestica (Nace et al., 1974; Richards and Lehman, 1980). The cricket, when dusted with a vitamin/mineral supplement (e.g. Pervinal by St. Aubrey, Division of 8 in 1 Pet Products, Inc., New York), has been employed successfully to maintain wild-caught and laboratory-reared frogs. However, it must be noted that some abnormalities may develop in laboratory-reared animals maintained throughout their lives on crickets alone (Lehman, 1978; Modzelewski and Culley, 1974).

Considerable literature exists regarding cricket husbandry (Gangwere, 1960; Thompson, 1977; Jordan and Baker, 1956; Haskell and Ives, 1954) but with the exception of Frost (1982), much of it is not readily accessible or is inadequate for the needs of investigators using crickets as forage. What follows is a step-by-step description of the cricket culture system employed at the Amphibian Facility and found economical. Although this system is suitable for producing and maintaining in excess of 1,000,000 crickets per month, the principles employed are applicable to much smaller operations such as those which might be housed in a converted refrigerator.

The objective is maximal production in the available area. Crickets may be cultured under "different" conditions but even slight modification of the conditions described here and used by the major commercial cricket breeders may suppress production. The life cycle objective of these procedures is egg to egg in 55 to 75 days; 8 to 15 days egg to hatching, 45 to 60 days hatching to oviposition. Optimal reproduction occurs in the first 14 to 21 days after reaching maturity (within 60 to 80 days from egg) and mortality by 100 to 150 days from egg. These values are useful in scheduling the lead time for cricket husbandry.

ENVIRONMENT

For good health and reproduction crickets require an appropriate balance between temperature and humidity. Temperatures between 29-32° C (84-90° F) are suitable with humidities between 70-85%. The higher the temperature the

higher the humidity that is needed. Temperatures greater than 32° C result in lethargic crickets and poor reproduction, while temperatures below 29° C inhibit growth and reproduction. While higher humidity, short of moisture condensation on enclosure surfaces, is tolerated without adverse effect, lower values adversely affect molting and result in mortality. The presence of partially molted individuals is the best indication that humidity is too low, i.e., they can't free themselves from the molt. Light can be minimal; our crickets are maintained in constant dark except when being tended and seem to grow better in the dark, although we have not distinguished between the influence of light level and stress caused by disturbance.

REARING CAGES

The twenty cricket rearing enclosures in our facility are well jointed wooden boxes (2.4 x .8 x .4 m) with closely fitted screen lids. Each enclosure is capable of holding 50,000-100,000 crickets depending upon their age, the available surface and the rate of use. A 10-15 cm strip of polished enamel paint around the inside top prevents escape of the crickets. The strip is kept smooth by treatment with paste wax. Note that this will not prevent escape of adult crickets, which have functional wings but fly only in the dark.

Critical to the successful culture and manipulation of large numbers of crickets is the control of surface areas within each enclosure. Older techniques employed stiff, non-toxic wood shavings or discarded egg cartons. The former was expensive, the latter cheap; but both required excessive time in cleaning and handling the animals. The current method is to use in each enclosure approximately 100 open ended rectangular cardboard tubes (30 x 10 x 10 cm) with 2.0 x 2.0 cm openings in the base of each side. These tubes are placed two rows abreast along the inside and ends of the enclosure. Open areas toward each end and in the center are used for food and water. Sufficient space should be left between each tube to permit the crickets to use both the inside and outside surfaces. The number of tubes in an enclosure should be adjusted to the numbers of crickets. This forces the crickets onto the vertical surfaces and facilitates handling. (Access to a template for construction of these tubes is available on request to us.)

Cages should be cleaned when they become fouled with exuviae, feces and uneaten food. Based on cricket density, approximately half our enclosures are cleaned after 2-3 weeks, others require no cleaning until after all crickets have been harvested. Cleaning is accomplished by sweeping, vacuuming (hand-held, low vacuum to allow recovery of crickets) and washing. Soap should not be used as it is toxic to the crickets. When a cage is cleaned all crickets are removed and transferred to another enclosure. Remove any standing water before reintroducing crickets: they quickly become waterlogged and die.

FOOD

Food should be available continuously and should be placed on paper plates to minimize the mixing of food and exuviae. A second objective is to encourage the crickets to distribute themselves throughout the enclosure. To this end the plates should be placed on top of the cardboard tubes at each end of the enclosure. While the crickets are still small, several plates of food should be placed on the floor at each end of the enclosure and additional food should be sprinkled throughout the cage. The latter practice should be discontinued, however, as soon as the crickets are large enough to climb or jump readily into the plates.

Food consists of a finely ground commercially prepared meal of 60% ground corn meal, 10% ground wheat meal and 30% chicken meal concentrate. This mixture is normally marketed as "chicken starter food." However, the commercial preparation is too coarse, especially for small crickets, and additional grinding is necessary. The "Feed Store" can do this. The extra expense of this grinding is recovered by better utilization of the food. Crickets may be maintained on ground corn meal alone, but this diet is inadequate for successful reproduction. No other food is needed.

WATER

The water source consists of two or more 1.9 l (2 qt) glass bottles inverted on plastic saucers (chick watering bottles). At a minimum, one bottle is placed at each end of an enclosure. Each bottle is ringed by a doughnut shaped foam rubber pad (2.0 cm thick, 13.0 cm diameter). The rubber ring must fit tightly so crickets do not encounter freestanding water and become waterlogged. When a bottle is refilled the foam rubber ring is rinsed clean in water. Never use soap as it is toxic to the crickets. Also, before use the oily residue in new foam rubber must be removed by boiling in a weak ammonia solution. Crickets eat synthetic foam but not natural rubber foam.

BREEDING SETUP

Under environmental conditions maintained at the Amphibian Facility most crickets become sexually mature (characterized by the presence of functional wings and complete genitalia) approximately 60 days after hatching, however some mature within 45 days. Crickets can lay between 2500 and 3000 eggs, with most reproduction occurring during the first weeks of sexual maturity.

Breeder enclosure

Our breeder enclosures are stocked with 5000 adult crickets and, depending upon the expected volume of use, 1000 additional crickets are added two or more times per week. Crickets transferred to the breeder enclosure should be about 60 days old to assure sexual maturity. Senile

crickets may remain in the breeder enclosure. Although they do occupy space and consume food, this strategy is cheaper than establishing new breeder enclosures or attempting to remove senile crickets. Dead crickets and accumulated wastes are removed once a month.

Plastic trays (40 x 25 x 5 cm) with edges roughened with sandpaper so hatchlings can exit easily, are filled with moistened peat moss to a depth of 2-3 cm and placed in the breeder enclosure as egg beds. The peat moss, at cricket temperature (29-32° C), should be moistened 24 h prior to use to assure thorough absorption of water by the medium. When placed in the enclosure the peat moss should be sufficiently moist to pass a few drops of water when a fistful is squeezed. If the peat moss is too dry egg deposition and survival suffer, if too moist, the eggs may drown or fungal growth occurs and the hatch may be reduced.

Depending on the desired hatch, as many as six such trays are placed on the floor of the breeder enclosure and some of the housing tubes are removed to encourage the crickets to move to the trays. These trays are left for 24 h and are replaced with an equivalent number of new trays so that egg deposition is not interrupted. The trays containing eggs are transferred to an incubation chamber to optimize the rate of development and to prevent cannibalization of the eggs and embryos by adult crickets. Be certain the trays are brushed free of adult crickets. A camel's hair dust brush is useful for this purpose.

Incubation chamber

The incubation chamber is maintained at a slightly higher temperature and humidity than the rearing room, usually 32-38° C (90-100° F) and 80-90% humidity. To ensure the peat moss is sufficiently moist the trays should be periodically sprinkled with water at incubation temperature. A child's sandbox sprinkler is useful. Experience will soon indicate the amount of water needed. This varies with local conditions but should be enough to keep the peat moss moist but not waterlogged. Examine the medium to its full depth to determine this.

After 7 days in the incubator, or when the first hatchlings are seen, the trays are transferred to a nursery cage. Under the temperature and humidity conditions of the culture room, the majority of eggs hatch within one week of transfer.

Nursery enclosure

The nursery enclosure should be free of all large crickets when trays are added. This is to avoid cannibalism. Trays resulting from 3 or 4 days of egg production (i.e., 18 to 24 trays) are placed in each nursery bin to produce a cohort of approximately 50,000 to 100,000 crickets. The

enclosures are covered with tarps to maintain high humidity, however, the trays are no longer sprinkled. After it is evident that many crickets have left the peat moss, light should be trained on the peat moss several hours each day to dry it and drive out the hatchlings. The peat moss is stirred to facilitate drying. This procedure is continued until (2 to 3 weeks) few hatchlings remain in the peat moss. The trays are then removed.

HARVESTING

At 2 to 3 weeks of age the crickets are sufficiently large (0.5-1.0 cm total length) to be fed to recently metamorphosed leopard frogs, although recently metamorphosed Bombina and Pseudacris require smaller crickets, and juvenile bullfrogs and Xenopus use larger ones. As crickets in a 100,000 cohort grow they are harvested for increasingly larger frogs. This reduces the numbers of crickets as their biomass increases and thus avoids exceeding the carrying capacity of the enclosure.

Be careful not to eliminate an entire cohort since 1000 or more crickets from each clutch are required for brood stock at 60 days of age. As a cohort decreases in number it is frequently combined with the preceding or following cohort, usually when one of the enclosures is cleaned. Enclosures rarely contain crickets from more than 6 or 8 days' production, although this is possible provided size differences are not excessive.

OTHER CONSIDERATIONS

Approximately 2 man hours per day are required for the breeding, feeding and cleaning operations to maintain a cricket colony of the size described above.

One caution is in order. Cricket exuviae and other dust generated by their culture is highly allergenic. Personnel working with the crickets on a regular basis should wear breathing masks. Research directors should insist upon this to avoid institutional liability for disability compensation. It can be that serious!

Constant attention to the equipment is needed to prevent the escape of crickets. Early instars can crawl through the screen lids so their access to the lids must be prevented by careful maintenance of the enameled and polished guard strip. Adults, which have functional wings, will escape through any unrepaired defects in the enclosures or lids. Of those which do escape, many can be trapped by strategically placing on the floor deep plastic pans provided with cardboard access ramps sprinkled with cricket food. Nevertheless some will become free-ranging and a source of difficulty with people in neighboring laboratories. Thus the rearing operation should be housed as much by itself as possible and doors and walls (openings around pipes and duct work) should be well

sealed. It is administratively heartening that these free-ranging crickets cannot survive in most parts of the United States. It is also assuring that, in contrast to cockroaches, crickets do not eat bookbinding paste or the paint of oil paintings.

Several hitchhikers may accompany the crickets. Over 20 species of spiders, one species of tenebrionid beetle, and a mite (probably Sancassania berlesei) have established themselves at the Amphibian Facility. The spiders prey upon crickets, the beetle competes with crickets for food and the mites parasitize the crickets. Control of these beasts is difficult or impossible and a small cricket loss is attributa ble to them. Fortunately frogs and other amphibians will feed on all of these hitchhikers. Thus, since the objective is to provide food, part of the loss is retrieved by feeding the hitchhikers as well as the crickets to the frogs. Note that our frogs prefer crickets to spiders, perhaps because the latter can bite back!

The following table is for your convenience.

	Weeks after hatching	size mm	Number of live crickets per 1,000 ml.
Hatchlings	0-1½	3-8	100,000-200,000
Small	2-3	5-10	20,000-50,000
Medium	4-6	8-18	4,000-9,000
Mature	8-10	15-25	1,000-1,500

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