The Sturnidae Husbandry Manual and Resource Guide

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A. Natural History

1. Taxonomy and Variation

The family Sturnidae is well-represented in zoological collections worldwide. The 114-sturnid species make up 29 genera. Feare & Craig (1999) offers the most recent and complete proposals for classification, therefore the Sturnid Species Interest Group has adopted this system of classification until further critical studies have been carried out.

Sturnid taxonomy has had many proposals regarding relations to other bird families. Traditionally Sturnidae was associated with Corvidae (Sibley and Ahlquist 1990), weavers (Von Boetticher 1931a) and African sugarbirds (Sibley and Ahlquist 1974), though DNA hybridization determined the family to be more closely related to thrushes (Turdidae) and Old World flycatchers (Muscicapidae).

Wide variation exists between many sturnid species, from the obvious range in color and body shape, to vocal capabilities and habitat preference. Limited captive and field research exists on many species. General and detailed species descriptions can be found in the **Recommended Reading List** found at the end of this manual.

Starlings are an Old World family except for introduced species, and occupy most habitat types. All members of the Sturnidae family tend to fall into one of two categories: Open terrain species that tend to have long wings and a short tail, and woodland or cliff species which tend to have short, rounded wings. Most starlings and mynahs have long strong bills and legs, are strong fliers, and are noisy and conspicuous. Many Asian species have evolved to live in treeless grassy areas. Only 2 African species, the African pied starling *Spreo bicolor* and the wattled starling *creatophora cinerea,* are found in this habitat type.

The amethyst starling *Cinnyricinclus leucogaster* is the most widespread African species, with breeding populations in western, eastern, and southern Africa. Most species are omnivorous, though oxpeckers are specialized feeders consuming ticks, ectoparasites, blood and fluids of their large mammal hosts.

The plumage of African species tends to be glossy while that of Asian species tend to be dull-colored, with browns, grays, and blacks. Most species are cavity nesters and use hollows in trees, cliffs, riverbanks, or the nests of other species.

2. Conservation Information

Five sturnid island forms have become extinct and seven species are globally threatened. Another twelve species are near-threatened. The critically endangered Bali mynah *Leucopsar rothschildi* is the only Sturnidae species with a conservation program in place.

The greatest threat to most wildlife, including members of the sturnid family, is loss, fragmentation, or degradation of habitat. The introduction of exotic or domestic predators, especially reptiles, rats, and cats, has also impacted avian species around the world. The European starling *Sturnus vulgaris* is a prime example of the catastrophic result of introducing an aggressive starling species and the potential impact on native bird species.

In parts of Africa and Asia some sturnid species are agricultural pests causing much damage to fruit plantations and cultivated areas. Various techniques are used to reduce the number of birds in these areas or to scare them from human habitation. Few of these techniques seem to be effective.

Some sturnid species, such as the wattled starling *Creatophora cinerea,* are valued in parts of Africa, as they consume vast quantities of locusts.

No species, with the exception of the superb starling *Lamprotornis superbus* and the Bali mynah *Leucopsar rothschildi* have actually reproduced frequently enough in captivity to keep up with the demands both in zoological institutions and in private aviculture. A large international pet demand still exists for the hill mynah *Gracula religiosa*. In Asia artificial nests are hung for

these birds and chicks collected at three weeks of age to be reared for the pet trade. Bali mynahs have suffered tremendously due to habitat loss and capture for the pet trade, as they are seen as a status symbol and are kept by many in cages throughout their native land (Craig and Feare 1999). The wild population of Bali mynah is presently less than 25 birds.

B. General Characteristics

1. Social behavior and structure

While starling and mynah species differ in many ways, most species show similarities in social structure and behavior. Only two sturnid species, the brown-winged *Aplonis grandis* and Shelley's starling *Lamprotornis shelleyi*, are frequently reported to occur solitarily or in pairs. Most species display gregarious tendencies, at least in some situations (Feare & Craig 1996).

By flocking, sturnids perform what is described as "demonstrated opportunism." In such cases members of the same species flock together to feed at a particularly good food source, such as fruiting trees or when insect "blooms" occur. Many species will also flock together to roost. Several mynah species are frequently reported to roost in family units (Feare & Craig 1999). During these occasions of species gathering, associations are made that stimulate interspecific interaction, familial interconnectedness, and pair-bond formation. Most of these flocking species then pair for a short amount of time each year to breed.

Differences in locomotory behavior also exist. Those species considered more terrestrial, such as the genera *Lamprotornis* (the glossy starlings) and *Creatophora* (wattled starling), often feed on the ground by walking and running about. Terrestrial feeding has brought with it the evolution of longer legs enabling these species to run quickly. The more arboreal and frugivorous genera *Mino* (yellow-faced mynah) and *Gracula* (Hill mynahs) have shorter legs and locomote by hopping. The more terrestrial the species becomes, the more omnivorous their diet and the more adapted the beak to prying and probing for food, while the more arboreal species tend to bite or peck into food or swallow food items whole (Snow 1981).

Many African sturnids live in shared ranges that link-up with other species outside of the breeding season (Traylor 1971). Occasionally mixed species flocks will roost together, as often observed in the genera *Acridotheres* and *Gracupica*. Extended families of some species have been reported as cooperative in their breeding (Craig and Feare 1999). Eleven species of African starlings are believed to be cooperative breeders, including the emerald starling *Lamprotornis iris*, but this breeding strategy has only been clearly documented in the African pied and chestnut-bellied starlings *Lamprotornis pulcher*. In these cases it is not known to what extent the extended family shares in nest building, chick rearing, or protection of territories.

2. Vocalization

Starlings are not great songsters, though most have distinctive flight calls and harsh alarm calls. In the case of many mynah and starling species, their ability to mimic sounds has led them to be kept as companions. The word mynah is actually derived from a Hindi word meaning a term of endearment such as "pet".

The flight calls of many of the glossy starlings might be described as liquidy chirps or whistles. Other species, especially the Bali mynah, superb starling), and the wattled starling, will often be seen perched with wings fluttering, delivering the cacophony of song similar to that seen and heard among flocks of common European starlings *Sturnus vulgaris*. Harsh alarm calls are very similar between species and are mutually recognizable (Craig & Feare 1999). The males of some sturnid species have been observed to sing with increased frequency as harsh weather conditions improve and at the onset of the breeding season (Gibson 1994).

Occasionally musical whistling calls, most of which are finely tuned and very soft, will be performed by some species. Recent research has shown evidence that the common European starling continues to learn new song elements from the sounds in their environment (Bohner 1990). The complexities of sturnid vocalizations continue to be a subject in need of further research.

Table A. Does your sturnid pair dominate other bird species? (Quest. 2K.)

Common name	***Species***		
African pied starling	*Spreo bicolor*	**No**	2/2 pair
Amethyst starling	*Cinnyricinclus leucogaster*	**No**	7/7 pair
Asian glossy starling	*Aplonis panayensis*	**No**	1/1 pair
Asian pied mynah	*Gracupica contra*	**Yes**	1/1 pair
Bali mynah	*Leucopsar rothschildi*	**Varies**	27/47 pair
Black-collared mynah	*Gracupica nigricollis*	**No**	1/1 pair
Black-winged mynah	*Acridotheres melanopterus*	**Yes**	1/1 pair
Emerald starling	*Lamprotornis iris*	**No**	11/12 pair
Golden-breasted starling	*Lamprotornis regius*	**No**	17/24 pair
Golden-crested mynah	*Ampeliceps coronatus*	**No**	6/7 pair
Greater blue-eared starling	*Lamprotornis chalybaeus*	**No**	2/2 pair
Grosbeak starling	*Scissirostrum dubium*	**No**	2/4 pair
Indian Hill mynah	*Gracula religiosa*	**Varies**	6/6 pair
Jungle mynah	*Acridotheres fuscus*	**No**	1/1 pair
Lesser blue-eared starling	*Lamprotornis chloropterus*	**No**	2/2 pair
Long-tailed glossy	*Lamprotornis mevesii*	**Yes**	1/1 pair
Metallic starling	*Aplonis metallica*	**Yes**	1/2 pair
Purple glossy starling	*Lamprotornis purpureus*	**No**	3/6 pair
Red-winged starling	*Onychognathus morio*	**No**	1/1 pair
Sulawesi crested starling	*Basiliornis celebensis*	**No**	3/3 pair
Superb Starling	*Lamprotornis superbus*	**Yes**	18/24 pair
Vinous-breasted mynah	*Acridotheres burmannicus*	**No**	2/2 pair
Wattled starling	*Creatophora cinerea*	**No**	2/3 pair
White-collared mynah	*Acridotheres cristatellus*	**No**	1/1 pair
White-necked mynah	*Streptocitta albicollis*	**No**	1/1 pair
Yellow-faced mynah	*Mino dumontii*	**No**	2/2 pair

3. Behavior and aggression

Most starlings and mynahs are potentially aggressive toward smaller birds at all times of the year and will need to be monitored. Aggression among sturnid species ranges from scolding calls to displacement and to actual pursuit. Aggression becomes most serious as one bird, or flock,

begins chasing a single bird or another flock. Occurrences of intraspecific squabbling do arise among some sturnid species, especially during the breeding season. Squabbling can also suddenly break out, for no apparent reason, throughout the year but is most commonly seen at the onset of the breeding season, a change of seasons, or by pairs protecting their nesting territory. Territorial behavior in starlings is largely limited to defense of the nest site (Stokes 1979). Occasionally actual physical combat occurs with birds locking feet and tumbling to the ground pecking at each other.

Infrequent and sudden bouts of fighting have been observed to occur among flocks of golden-breasted starlings, superb starlings, and other African glossy starlings. It is likely that this occurs among many, if not all, sturnid species when held within the largely unnatural confines of captivity. The incidence of squabbling among familial flocks of sturnids may be much reduced, perhaps due to their close association, as this has been the case among such a flock of golden-crested mynahs at Disney's Animal Kingdom (DAK) and has been reported among superb starlings. Further captive data will need to be collected to confirm this.

When flocks of sturnids are kept in large aviaries, interspecific squabbling and fighting is often seen during the breeding season when birds intentionally or inadvertently enter the breeding territories of other birds. For example, superb starlings will often invade the nesting territories of other birds in an attempt to steal favorable nesting material or to take over the nest site entirely, a feat at which they are often successful. Grosbeak starlings *Scissirostrum dubium* can be very disruptive in a mixed species aviary as their natural curiosity drives them to investigate every vacant or occupied tree hollow, nest box, or potential nesting crevice.

Table B. If in a mixed species aviary, what social status do your sturnids appear to hold?
Aggressors __ Submissive __ Instigators __ Oblivious of others__ Other ___ (Question 2L)

Common name	**Scientific name**	**Behavior** (# / of total pairs)
Amethyst starling	*Cinnyricinclus leucogaster*	Submissive or Oblivious (9/9)
Asian pied starling	*Gracupica contra*	Oblivious (2/2)
Bali mynah	*Leucopsar rothschildi*	Aggressive (6/17) / Oblivious (16/17)
Black-collared starling	*Gracupica nigricollis*	Aggressive at nest site (2/2)
Black-winged mynah	*Acridotheres melanopterus*	Aggressive at nest site (1/1)
Emerald starling	*Lamprotornis iris*	Submissive or Oblivious (8/12)
Golden-breasted starling	*Lamprotornis regius*	Oblivious (14/17) / Aggressive (4/17)
Golden-crested mynah	*Ampeliceps coronatus*	Oblivious or Submissive (7/7)
Greater blue-eared starling	*Lamprotornis chalybaeus*	Aggressive (3/3)
Grosbeak starling	*Scissirostrum dubium*	Instigator or Dominate (4/4)
Indian hill mynah	*Gracula religiosa*	Entire range (6/6)
Long-tailed glossy starling	*Lamprotornis mevesii*	Oblivious (1/1)
Purple glossy starling	*Lamprotornis purpureus*	Entire range (6/6)
Sulawesi crested starling	*Basiliornis celebensis*	Oblivious / Instigator (3/3)
Superb starling	*Lamprotornis superbus*	Aggressive or Instigators (18 / 24)
Vinous-breasted mynah	*Acridotheres burmannicus*	Submissive (2/2)
Wattled starling	*Creatophora cinerea*	Dominant at feeding stations (2/4)
White-collared mynah	*Grafisia torquata*	Instigators (1/1)

Sturnids by nature are very curious and may become interested in the newly fledged offspring of other aviary inhabitants. This curiosity also includes the investigation of newly introduced bird species, both perching and ground dwelling. Care must therefore be taken when new birds are brought into any mixed aviary, and frequent observations are necessary during and after introductions so that prompt measures can be taken should aggression or distress occur. In many

cases sturnid curiosity, if not of a serious nature, is short lived and after initial investigation the curious birds move on to something more interesting.

Because sturnid species differ in their aggressive nature and species traits, reviewing individual species characteristics is critical to helping determine what species might fit better into a mixed species aviary. **Tables A & B** describe species characteristics taken from survey data.

4. Molting

In captivity some starling and mynah species may replace, or molt, feathers in a very noticeable fashion while others species are less obvious. We have observed regular feather loss primarily on the heads and necks of Amethyst starlings, superb starlings, and Bali mynahs. Less dramatic feather loss has been reported in golden-breasted starlings and emerald starlings.

The molting pattern of amethyst starlings can be quite startling, losing most if not all of the feathers of the head, those surrounding the eyes, and sometimes much of the neck, making the birds look as though they might be suffering from disease or illness. **Table C** shows the survey data pertaining to molts and how recognizable they may be among species.

Table C. Species noted to enter an obvious molt. (Quest.2J)

Common name	Species name
Asiatic glossy starling	Aplonis panayensis
Amethyst starling	Cinnyricinclus leucogaster
Bali mynah	Leucopsar rothschildi
Emerald starling	Lamprotornis iris
Golden-breasted starling	Lamprotornis regius
Indian hill mynah	Gracula religiosa
Purple glossy starling	Lamprotornis purpureus
Superb starling	Lamprotornis superbus
Wattled starling	Creatophora cinerea

It is important to record molting seasons and physical characteristics of the molting cycle in each species. Because the physical appearance of a sturnid in molt may be striking, it is necessary for caretakers to recognize and understand this biological process.

Molt can be affected by environmental conditions. Suspension or interruption of the molt cycle may occur in any bird species due to food shortages, extended migratory distances, environmental stresses such as inclement weather or disturbances by other birds and animals (Craig 1996). Rather than synthesize proteins stored in pectoral muscle tissue for feather growth, birds may direct this use of energy toward more critical physiological or biological functions such as acquiring food when it has become scarce. Poor molts in captivity are sometimes a result of poor nutrition or may be caused by unnatural photoperiods.

The only starling species showing seasonal changes in plumage related to breeding, is the wattled starling (Feare & Craig 1999). Most sturnid species undergo a single complete molt annually, usually completed after the breeding season. Some migratory species may change timing of the molt, for example the amethyst starling, which may breed, molt, and then migrate; while other amethysts may molt, migrate, and then breed. This species is also unusual in that the wing and tail molt are completed well before the molt of the body plumage (Traylor 1971). Different stages of molt may also be present in the same flock of the same species (Feare 1996). Most Asian sturnid species, and many African species, experience a post-breeding molting cycle. In the more migratory sturnids, primarily African species and the common European starling, molting may be less systematic.

C. Enclosures and exhibit design

1. Enclosures

Most sturnid species are quite adaptable when it comes to housing requirements, and they can be contained in a variety of enclosures. When designing habitats, it is important to keep in mind the species' natural environment and the prevalent components that make up the niches within. The

species' natural history and range maps, as well as individual history if captive reared, all come into play when designing optimal habitats. Enrichment programs, effective exhibition, and opportunities for study and research can be easily incorporated into a well thought out habitat. (Refer to the **Recommended Reading List** at the end of this manual for individual species natural history information).

Attempting to mimic natural habitat components will offer the opportunity to maximize the overall well-being of your sturnids and perhaps their reproductive success. Predominant components of such habitats may simply include keeping an enclosure arid and sparsely vegetated for species that inhabit such environments, or the reverse, installing many visual barriers and providing higher humidity to create a more tropical atmosphere.

Most sturnid species are exceedingly active birds, and it is important to give them as much space and natural "furniture" as possible. Although smaller flights 3-4 feet in length may be useful for temporary housing, these will likely adversely effect the long-term health of the birds. Even birds confined to smaller enclosures, whether because they are new imports in quarantine, shut indoors during periods of inclement weather, or recovering from illness will benefit from access to larger flights.

Table D. In which area do your sturnids spend the greatest portion of their day? (Q. 2A)

On ground Lower canopy Mid canopy Upper canopy

Common name	Scientific name	Time spent
Amethyst starling (9/9)	Cinnyricinclus leucogaster	Mid-canopy
Bali mynah (32/47)	Leucopsar rothschildi	Upper canopy
Lesser blue-eared starling (3/3)	Lamprotornis chloropterus	Upper canopy
Emerald starling (11/12)	Lamprotornis iris	Mid-canopy
Golden-breasted starling (24/24)	Cosmopsarus regius	Mid to upper canopy
Golden-crested mynah (7/11)	Ampeliceps coronatus	Mid to upper canopy
Grosbeak starling (4/4)	Scissirostrum dubium	Upper canopy
Indian hill mynah (6/6)	Gracula religiosa	Upper canopy
Vinous-breaseted mynah (3/3)	Acridotheres burmannicus	Upper canopy
Purple glossy starling (6/6)	Lamprotornis purpureus	Mid to upper canopy
Sulawesi crested starling (3/3)	Basiliornis celebensis	Mid to upper canopy
Superb starling (24/24)	Lamprotornis superbus	Upper canopy
Wattled starling (4/4)	Creatophora cinerea	Mid canopy

The individual species' characteristics should somewhat dictate the design of the enclosure. Species such as amethyst starlings and emerald starlings are primarily upper canopy dwellers, whereas superb starlings and golden-breasted are likely to inhabit the mid-canopy and the aviary floor. **Table D** reviews survey data describing where some species tend to spend the majority of their day while in captive habitats.

The requirements of specific species in relation to exhibit structure (vegetation densities, visual barriers, variable nesting sites, etc.) is an important consideration prior to attempting to mix species. If serious breeding is planned, it is best to limit the number of birds and species in the aviary. Rather than exhibiting numerous sturnid species in a single large flight it might be advisable to house one or two amicable species in a single aviary, thereby enhancing conditions more favorable for both species' reproductive success.

2. Aviary Size

Individual starlings differ in their degree of flightiness, and imported birds may behave differently than those that are captive reared. The size of an aviary should depend on your ultimate goals.

Vast aviaries and conservatories are spectacular exhibits for sturnids, entrancing visitors with their brilliant colors and inquisitive antics, while smaller aviaries, likely housing fewer birds, have the benefit of creating microenvironments offering sturnid species security and breeding opportunity.

The superb starling and the hill mynah are two species that have been bred in busy home living areas in cages measuring just 3 feet square. The amethyst starling, though highly arboreal, has nested in aviaries measuring less than 2m square and 2m long. The best recommendation is to give the birds as large a space as possible in keeping with the available resources.

3. Aviary size recommendations

Although pairs of starlings have bred in enclosures as small as 3 ft square (.9m), we recommend a minimum enclosure size for a breeding pair of sturnids to be 8'long x 3'wide x 8'high (2.4m x 0.9m x 2.4m high). The ideal breeding enclosure size, as recommended by the Bali mynah husbandry manual, is 1.2m x 2.1m x 4.5m (4 ft x 7 ft x 15 ft). For wire enclosures, mesh size should not exceed one inch square and should be smaller for outdoor exhibits in order to limit the entry of pests.

Live plants, dried shrubs, or silk plants should be incorporated into your sturnids' environment. The birds will quickly realize the boundaries of their enclosures if they are solid or made of mesh, but if any of the enclosure walls are glass, as many zoo exhibits are, precautions should be taken before birds are introduced. The best method is to paint the glass areas with a light coating of nontoxic water-based white paint, greenhouse glass paint, or to cover the windows with paper. Gradually removing the covering over the course of a week should give the birds plenty of time to adjust to the enclosure boundaries.

The general principle of providing as large an enclosure as possible should be applied. Whether housed in enclosures large or small you will find that frequent and close human contact will cause your birds to develop a combination of wariness and familiarity that has served the Sturnidae family well.

4. Introduction or "Howdy" cages

Introduction cages incorporated into an aviary design serve to gradually introduce species to their new habitat, temporarily house problem species, and function as trap cages when species need to be captured. If the introduction cage is large enough, it can house birds recovering from injury or ailments in an environment far less stressful than one far from familiar territory and possibly a mate. Mate introductions can more easily be assessed and monitored when managed using the howdy cage protocol.

Gradual introductions to other bird species and to habitats can be effectively accomplished in spacious introduction cages. Making howdy cages of suitable size will allow for greater flight distance for the new resident, allowing the bird to maintain its physical fitness and giving them space in which to assess other species and to be assessed.

Becoming comfortable and familiar in the howdy cage during introductions will make the birds more likely to return to the cage and easier to capture when needed. Always having the howdy cage accessible to the birds and offering food and water from inside will keep the birds in the practice of entering without suspicion. Keeping introduction cages conveniently operational also has advantages. This implies that the caretaker always has easy access to the closing trigger (i.e.

string or tripping device) that will shut the birds in the cage. Having a trap cage in the set position will allow you to opportunistically trap birds that are not always easy to catch. Once caught, weights, measurements, and physical examinations can be performed.

5. Safety doors and passages

It is important to include a safety passage, or double door system, into the aviary, as sturnids are not only fast and acrobatic flier, but their curiosity may lead them to escape through loosely latched doors or be frightened and get past you through the door when least expected.

D. Optimal aviary components

1. Visual Barriers and Habitat Furnishings

Visual barriers can be in the form of plants (real or artificial), walls, trees, curtains, etc. The length of an enclosure also provides the barrier of distance. In mixed species aviaries, and even in smaller enclosures holding a single pair, it is important that birds are able to hide to avoid aggression. Grasses, plants, and trees are the most common forms for providing birds with hiding and roosting places. Partial barriers can also be created by hanging shrubs, clumps of grasses, bamboo and dense fabric curtains from the ceiling of the enclosure. These also provide shade and shelter. **Table E** reviews planting density and its possible relationship to reproductive success. No statistical correlation was found between the plant density of an aviary and breeding success, although aesthetically plants add greatly to the captive environment.

Table E. How is your enclosure planted? (Quest. 1K)			
Have bred (51 pairs total)		Have not bred (63 pairs total)	
Lightly planted	22%	Lightly planted	12%
Moderately planted	59%	Moderately planted	78%
Densely planted	20%	Densely planted	31%

Natural enclosure furnishings are important components that influence normal behaviors, good health, and overall well being in all animals. Birds will be more motivated to perform natural behaviors in the types of enclosures suitable to their species' needs.

Frequently it is felt that area noise levels may be disturbing to various bird species, preventing them from behaving normally and possibly interrupting daily life. **Table F** reviews noise levels in the vicinity of breeding sturnid species. No correlation was found to exist between low, moderate, and high noise levels in the vicinity of enclosures and reproductive success. Pairs appeared to reproduce in spite of what we might consider excessive noise levels. This is likely due to the bird's capabilities of adjusting to their surroundings and to human routine.

*Table F. Noise levels in the vicinity of your sturnid pair? (Quest. 3C)				
	Visitor	Machinery	Animal	Other
Pairs that have bred	2.7	1.3	1.9	2.3
Pairs that have not bred	2.8	1.6	1.9	2.5
*Table Key	Low	Medium	High	
Noise range	1 2	3	4 5	

2. Perching

Arid zone and terrestrial sturnid species such as superbs, golden-breasts, and wattled starlings spend much of their time perched in the open where they can see as well as be seen. Forest dwelling varieties such as amethysts, emerald starlings, and golden-crested mynahs will spend more time in the cover of the canopy. When perching an enclosure, one must recognize these species' traits. Less open perching is necessary in enclosures for forest dwellers so time would

be better spent adding thick shrubs, trees, and hide spots rather than large pieces of deadfall for perching, while the reverse in true for open arid zone species which also make good use of floor space. It is important to make sure that the birds are afforded shade in the area in which they spend much of their time. Sunbathing and rain bathing are enjoyed by most sturnid species so perches located in open areas will be useful.

Natural tree branches are some of the most desirable to use for perching. Branches that vary in size, naturally tapering to include diameters ranging from 1/2"-1", will give the bird's feet adequate exercise as well as giving them sturdy footing on which to perch.

3. Water Provision

All sturnid species bathe in one way or another. **Table G** offers survey data describing the frequency in which some species are observed to bathe. Though some birds are described as never bathing this may be a case of timing or because the birds do not have facilities conducive to their species' bathing style. Some species bathe in shallow dishes while others, most often arid-zone and terrestrial species, prefer to bath in rain or light mists and sprinklers. Some forest species are likely to bathe by brushing against wet vegetation or in a sprinkling rain. You will find that some will bathe daily and others not as frequently. Most species are adaptable and providing birds with an occasional misting or sprinkling may eventually encourage them to bathe.

4. Substrates

Naturally planted earth floors are some of the most aesthetically pleasing of habitats for zoo visitors as well as aviary inhabitants. Many species, especially the more terrestrial, are often found busily foraging on the floor of their enclosure.

Aviary substrates, whether earth, pebble, sand, or cement can be covered with leaf litter, wood chips, grass sod or any other natural material providing birds with detritus to sift through for insects and nesting material. Material to probe and forage through not only offers enrichment but also provides abrasive surfaces that help keep beaks and claws trim. Small pebble and sand substrates are very desirable in high use areas, smaller breeding flights, and off-exhibit aviaries. These substrates can be raked and sifted through ¼" mesh bottomed boxes or sieves leaving behind cleaned substrate, the detritus having been caught in the box.

Good drainage beneath aviaries, such as a French drain system, will keep substrate in clean and healthy condition, even allowing an occasional rinse with a mild disinfectant solution when necessary. The negative side of earth floors, is of course, the difficulty in sanitizing or disinfecting. And since many sturnids are susceptible to Atoxoplasmosis, the inability to thoroughly sanitize a floor can reduce the effectiveness of treatment programs.

5. Maintenance

General cleaning of aviaries will depend on the numbers of birds within, species kept (more frugivorous species defecate more frequently and more copiously), whether they are indoors or outdoors, the need to avoid disturbing breeding birds, and aesthetic preference. It is best to establish a routine as birds will quickly adapt and feel more secure in their surroundings once they have become familiar with cleaning and feeding schedules.

Table G. Frequency sturnids have been reported bathing in captivity (Questtion 2G)		
Common name	***Species***	**Frequency**
Amethyst starling	*Cinnyricinclus leucogaster*	**Never**
Asian pied mynah	*Gracupica contra*	**Seldom**
Asiatic glossy starling	*Aplonis panayensis*	**Seldom**
Bali mynah	*Leucopsar rothschildi*	**Frequently to Daily**
Black-collared starling	*Gracupica nigricollis*	**Seldom**
Black-winged mynah	*Sturnus melanopterus*	**Seldom**
Greater blue-eared starling	*Lamprotornis chalybaeus*	**Seldom**
Emerald starling	*Lamprotornis iris*	**Never to Seldom**
Lesser blue-eared starling	*Lamprotornis chloropterus*	**Never**
Golden-breasted starling	*Lamprotornis regius*	**Seldom**
Golden-crested mynah	*Ampeliceps coronatus*	**Seldom to Frequently**
Grosbeak starling	*Scissirostrum dubium*	**Frequently**
Indian Hill mynah	*Gracula religiosa*	**Seldom to Daily**
Vinous-breasted starling	*Acridotheres burmannicus*	**Never**
Jungle mynah	*Acridotheres fuscus*	**Seldom**
Long-tailed glossy	*Lamprotornis mevesii*	**Never**
Metallic starling	*Aplonis metallica*	**Never**
African pied starling	*Spreo bicolor*	**Seldom**
Purple glossy starling	*Lamprotornis purpureus*	**Never**
Red-winged starling	*Onychognathus morio*	**Never**
Sulawesi crested starling	*Basiliornis celebensis*	**Never**
Superb Starling	*Lamprotornis superbus*	**Seldom to Daily**
Wattled starling	*Creatophora cinerea*	**Seldom**
White-necked mynah	*Streptocitta albicollis*	**Seldom**
White-collared mynah	*Acridotheres cristatellus*	**Seldom**
Yellow-faced mynah	*Mino dumontii*	**Seldom**

Long-range plans, whether they are collection management decisions, enclosure construction, or habitat landscaping, should be well planned to avoid disturbing the birds during seasonably poor weather or breeding seasons. Allowing the birds acclimation time to settle into a new environment is good assurance for their immediate and future well being.

6. Weather protection and night-lights

Although sturnids are hardy subjects and can tolerate a good range of temperatures, climatic extremes may harm them. Though most species are vigorous, frost-free quarters are a must during the winter, while outdoor flights may be used to advantage during the summer months. All species need to be brought into warmer accommodations if temperatures remain below freezing for weeks on end. Even in mild climates, the birds should always have access to heated, frost-free shelters.

If temperatures drop to below 45°F (7°C) for brief periods throughout the winter months, a simple 250 Watt infrared heat lamp will make the birds more comfortable. Newly acquired birds should be given heat and shelter if there was not ample time to acclimate them to the changing temperatures for several months prior to the cold season. A good rule of thumb is not to release newly acquired birds into outdoor enclosures until nighttime temperatures are consistently 50°F (10°C) or above.

Table H. Are your birds housed indoors or outdoors? Quest. 1B.			
~~Have bred~~ (45 pairs total)		~~Have not bred~~ (63 pairs total)	
Housed indoors	**50%**	Housed indoors	**42%**
Housed outdoors	**31%**	Housed outdoors	**48%**
Outdoor/Indoor seasonally	**19%**	Outdoor/Indoor seasonally	**10%**

Summer temperatures in excess of 95°F (35°F) also call for cooling measures for the birds. Well-planted and shaded areas of the enclosure may be enough for the birds to find relief from the heat, but if temperatures climb higher it will be necessary to give them a light water misting on occasion during the day. Most sturnids love to bathe in the spray of water and the birds should always have access to a water dish large enough for both drinking and bathing.

Table H reviews information with regards to breeding starlings indoors, outdoors, or both. Survey data reveals that the majority of captive breeding sturnid pairs are housed indoors and no significant correlation was found to exist between accommodating pairs indoors or outdoors and reproductive success. Table H shows that housing sturnids in indoor enclosures, with seasonal access to outdoor enclosures, may enhance their overall condition, making them reproduce more readily.

7. Nightlights

Because birds may experience frights during the night that may cause them to fly erratically, it is important to supply some sort of illumination to help prevent them from injuring themselves. For those kept indoors a simple 4 to 10 watt night light will suffice, while those housed outdoors will benefit from area path lighting, parking lot lights, or from leaving a doorway light on. Low wattage, single incandescent bulbs in ceiling fixtures also effectively simulate moonlight.

E. Introductions

1. Introducing Birds

All passerines should be housed in introduction cages, or “howdy” cages, before being released into an aviary already occupied by other bird species. It is even good practice to "howdy" birds into a new unoccupied environment so that they become familiar with the introduction cage which will likely later become their trap or feeding cage. Birds need time to adjust not only to the present aviary residents, but also to the noise levels, ambient temperature and weather conditions, and to the present photoperiod if they have been brought from another latitude. They can also learn the geography of the exhibit, especially where other food sources are, by watching existing residents.

The length of time spent inside an introduction cage will be influenced by the species already in the aviary. A longer introduction period should be employed when numerous bird species are involved. Both large and small residents will need consideration and both will need ample time to investigate the “howdy” cage and its occupants. During this time the birds may determine each other’s species characteristics and perhaps get to know necessary flight distances, and become familiar with the each other’s presence. In most cases an introduction period of from 3 to 8 days should cover the necessary adjustment period.

Most importantly “howdy” cages give the caretaker an opportunity to spend time observing and noting any interactions that take place between both species, and conspecifics. Data, such as vocalizations, postures, displacement activities, etc. collected during the introduction period will help describe future interactions once the birds are released.

Many sturnid species can be kept with other bird species. Generally, the larger the habitat the more varied the species that may amicably coexist. Reviewing the survey results in **Tables A through D,** the general characteristics section of this manual, and reading from the suggested

book list found at the end of this manual, will enable the reader to better predict the behavior of particular sturnid species.

F. Sociability and Influencing Behavior

1. Sociability

It may be unfortunate that most captive sturnids are usually maintained in pairs. Most species' natural history indicates that they occur in family groups and larger flocks for most of the year. Most species available from importers are those that frequently flock, only pairing off for a brief period in which to breed.

From the above statements, we may infer that captive sturnids maintained as single pairs are not able to interact in ways that may be more beneficial for their overall well being and reproductive success.

Other environmental phenomenon such as rainfall, insect blooms, the fruiting of trees, and migrations also influence wild populations. Though captive environments may appear to imitate wild habitats and conditions of many bird species (occasionally some to near perfection) we have yet to understand and mirror the changing social variance that occurs among sturnid species. Seasonal flocking, and the interactions involved, is one important consideration that may hold the key to what triggers pairing. Familial cohesion and relations, the seeking out of breeding territories, and involvement in reproduction and chick rearing are also components. Missed social opportunities may leave single captive pairs lacking in ways unclear to their caretakers.

Because many wild starling species flock both during and outside the breeding season, enhanced captive reproductive success may result if they are given similar opportunities in captivity. Maintaining species that are known to flock, in flocks outside of the breeding season and then separating them for breeding may improve pairing and reproductive success. Other species may reproduce better if maintained in larger flocks in large aviaries, allowing the pairs to disperse and breed. Some golden-breasted starling pairs have produced young while maintained in trios of two males per female. All of these situations demonstrate the need for further study and experimentation in the ways in which sturnids are managed.

In circumstances where captive habitats are large enough to give the birds sufficient space and vegetation, many species will coexist quite amicably. Some collections have maintained five starling species, in flocks of 4-12 individuals, with little incidence of inter and intra-species squabbling.

Maintained in large and small aviaries, sturnids show a wide variety of behaviors and will investigate and use much of their environment. In large aviaries some terrestrial species, when compared with more arboreal species which hide themselves high in the tree canopy, are much easier to observe. The very terrestrial golden-breasted and superb starlings seem to be very curious, investigating new pieces of aviary furniture, new aviary inhabitants, nestboxes, tree cavities, rock crevices, and any small detail, especially those objects making any movement which catches their eye. More arboreal sturnid species are much more difficult to observe because of their habitat niche. Some of these species, such as the emerald and amethyst starlings and the golden-crested mynah, may exhibit behaviors that are more difficult to detect or that are subtler in nature.

Most sturnid species are expected to be active in the morning and in the early evening, but any may become active at any time of the day, especially when a feeding opportunity presents itself. With the approach of more favorable weather, a change in the photoperiod, or onset of the breeding season the birds' activity level will change, stimulating courtship behavior. At these times some species will be observed chasing each other in flight, vocalizing more often, and many species will begin to carry small leaves and other objects in their bills, often while pursuing another bird.

2. Sturnids as predator alarms

Sturnids often engage in raspy and throaty scolding calls when they are protesting the invasion of their habitat by a predator. Such potentially dangerous animals include rats, raptors, cats, and snakes. Some starlings will pursue raptors, chasing and diving at them until they flee the area. Potential predators are often approached quite closely by the birds, whether on the ground or in a tree, and scolded loudly. Interestingly, this demonstrative alarm calling will alert other aviary inhabitants to the predator, affording them opportunity to join in the harassment of the invader or to avoid danger. In the case of alerting the caretaker, the invading danger can then be captured and removed from the area.

3. Influencing sturnid behavior

Experience has taught us that various enrichment or feeding techniques can be employed to make many bird species more visible. Initially it may take some time to condition birds to a bridge (device used to alert your birds to your intention and presence) but eventually, at least with sturnids, little effort is needed after they have recognized their caretaker or become conditioned to respond to a cue.

There are a number of ways in which we can influence the birds to come into view or to a specific target for weighing or collecting other data. Techniques can be employed to bring birds into closer proximity to the observer if it is known what interests the birds. **Table I** reviews some items that may interest your sturnids and bring them to the ground or into better view of the observer.

Some species will quickly come into view if offered something desirable. For many species this would be a favorite food item, such as insects or fruit. Desirable nesting material is also likely to prompt other species. In the case of many captive golden-breasted starlings there seems to be a curiosity with small white objects. They will very often come close to the observer if just a couple of small white feathers are tossed nearby.

Table I. How often do your sturnids come down to the ground and why? (Question 2C)

Common name	Scientific name	Frequency and Why
Amethyst starling (9)	*Cinnyricinclus leucogaster*	Frequently-To forage
Bali mynah (32)	*Leucopsar rothschildi*	Frequently-To forage
Emerald starling (11)	*Lamprotornis iris*	Infrequently-To drink
Golden-breasted starling (24)	*Cosmopsarus regius*	Frequently-For food and to forage
Golden-crested mynah (7)	*Ampeliceps coronatus*	Infrequently-For insects and nesting material
Grosbeak starling (4)	*Scissirostrum dubium*	Infrequently-For food and water
Indian hill mynah (6)	*Gracula religiosa*	Infrequently-For food and water
Lesser blue-eared starling (3)	*Lamprotornis chloropterus*	Infrequently-For insects
Purple glossy starling (6)	*Lamprotornis purpureus*	Frequently-For insects and nesting material
Sulawesi crested starling (3)	*Basiliornis celebensis*	Infrequently-For food and water
Superb starling (24)	*Lamprotornis superbus*	Frequently-For nesting material
Vinous-breasted mynah (3)	*Acridotheres burmannicus*	Infrequently-For food and water
Wattled starling (4)	*Creatophora cinerea*	Frequently-For food and water

a. Operant conditioning

The curious nature that has served most sturnid species well also lends itself to influencing the birds' behavior following the rules of operant conditioning. In any bird collection, whether mixed species aviary or single species flight, relative success can be achieved in training birds. A specific and favored reward can be used to motivate the birds into action and persuade them to do what is required. Conditioning (training) birds and bringing them into closer proximity to caretakers and other observers improves viewing and offers an opportunity to assess physical condition. Bringing birds into better view also enhances the zoo visitor's experience.

As a management tool operant conditioning may eventually allow the birds to be positioned onto a scale for remote weighing, attract them into howdy or catch-up cages, and in a large planted aviary, to simply count them each day for accurate inventories.

This form of training can be applied to many, especially those that are instinctively food motivated and/or curious in nature. Sturnids quickly learn to respond to the behavior and routine of their caretakers. Each time the caretaker offers the birds a favored food item they first activate a specific cue or "bridge". This is easily accomplished by using a device to get the bird's attention, such as a clicker, or by jingling keys, or by using some other noise-making device.

Some of the more terrestrial sturnid species, such as the golden-breasted starling, are easily conditioned to respond to their caretaker when offered insects. Upon entering the aviary the caretaker uses the cue to alert the birds. Each time the bird approaches closer to the final goal (steps in the direction to the desired behavior, location, or target) they are given a reward (tossed an insect). Each of the steps in the right direction, toward the final target, is referred to as an "approximation". Eventually, the birds, after being given the cue, will only be given an insect when they have reached the final target. The bird species' learning curve will determine the speed with which it accomplishes the targeted behavior. Most bird caretakers do not realize that they have been conditioning their birds all along. Each time they attract their birds and give them a treat, they have employed the rules of operant conditioning. This training and conditioning approach will work with bird species in both smaller enclosures and enormous aviaries. **Table I** offers suggestions, taken from survey data, with regards to what items might interest sturnid species and bring them into better view.

F. Diets

1. General nutrition

The sturnid family is likely one of the most omnivorous of all softbilled groups. While most starlings eat insects and the mynahs are more frugivorous, overall the family will take advantage of what food items present themselves and are readily available. In captivity the more varied the diet the better for most species.

Most sturnids are gregarious, especially at food sources. Many Asian species are more frugivorous while most African species are omnivorous. Of the African species those that are arboreal tend to have shorter legs and walk less on the ground in search of food. Terrestrial species have longer legs, allowing them to walk and run quite quickly, and to pursue more animal food than more arboreal species.

Ideally an easily maintained balanced diet should be routinely fed. Nutritionally sound and commercially produced pelleted or softbill diets, along with fruits, vegetables, insects, and if necessary, some sort of meat will make up the basis of the captive diet. All combined these ingredients should provide your birds with a daily balanced diet. Sturnids are susceptible to hemochromatosis and consideration should be given to the iron content of the ingredients of their diet.

Table J. Iron levels found in some popularly fed sturnid foods. (Iron level tests performed in August 2000, levels vary from batch to batch) (Boyer 2000)		
	Product	**ppm iron**
1	Mazuri Zulife Bird Gel 5ME4	67
2	Mazuri Low Iron Gel	20-30
3	Mazuri Jungle Gel 5ME1	48
4	Mazuri Parrot Breeder Pellet	234
5	Mazuri Small Bird Breeder Pellet	225
6	Prettybird Select Softbill Diet	68-90
7	Hagen Softbill	68
8	Zeigler's Bird of Paradise	69
9	Prettybird Handfeeding formula	101
10	Harrison's	118
11	Bogena Mynah Food	121
12	Bogena Mynah Granules	193
13	Quiko Mynah Bird Food	142
14	Wayne's Dog Food	202
15	Reliable Prtoein Products Low iron Softbilled bird-fare	203
16	Kaytee Exact Original Softbill and Mynah Pellets	208-220
17	Kaytee Handfeeding Fromula	485
18	Scenic Apple Paradise	228
19	8N1 Ultra Blend	241
20	Science Diet Feline	249
21	RAFF Realpasto Universal w/Fruit	299
22	Zupreen Monkey Chow	302
23	8N1 Tasty Dinner	362
24	Piki Crumble	462
25	Higgins Vita Crunch	221
Foods tested at California Animal Health & Food Saftey Laboratory-System Davis (CAHFS) POB 1770, Davis, CA 95617 Telephone (530) 752-8700		

The iron content should be listed on the packaging of manufactured diets in parts per million (ppm). **Table J** shows the ppm iron content of pelleted diets and other ingredients that are commonly fed to sturnids in captivity.

Fresh fruits and vegetables are important dietary ingredients. These are most often fed diced, chopped, or shredded into more or less bite-sized pieces. Consumption of fruits and vegetables varies between species. Offering different seasonal fruits and berries provides additional stimulus and nutrition while chunks of fruit and vegetables skewered onto branches or feeding platforms may attract some species. **Table K** shows a list of fruits and vegetables commonly offered to sturnids. Some fruits and vegetables that should be avoided until more research data is collected are raisins (potentially high in iron), avocados (potentially high levels of lipids and vitamin E), and citrus fruits (citric acid may increase absorption of iron, contributing to hemosiderosis).

Table K. Suggested Fruits and Vegetables (Chopped, shredded, whole, and some cooked)	
Fruits	
Apple	Grapes
Pear	Tomatoes
Banana	Oranges
Raisins (soaked)	Papaya
Figs	Guava
Blueberries	Strawberries
Vegetables	
Carrots	Corn
Sweet potato	Peas
Kale	Green beans
Romaine lettuce	Squash
Escarole	Bean sprouts

Supplementation with multivitamins and minerals is usually guesswork (Brue 1995). To help minimize imbalances, commercially formulated pelleted diets should be used to substitute for as much natural food as possible, or as much as the birds will tolerate.

Table L shows samples of diets that are fed to various sturnids in captive collections. All of these diets are fed to birds that share their enclosures with various, often numerous, other avian species that cover a broad range of taxa. Some of these sample diets are fed to predominantly frugivorous or insectivorous sturnid species, hence the variability in fruit components. When providing diets for a mixed sturnid species aviary the birds will have access to a broader range of ingredients. This must include carbohydrate, protein, and fat components that will provide the

necessary nutrition to bird species which may include those that are omnivorous, insectivorous, frugivorous, and nectivorous. The **Diet Item Resource Guide** at the end of this manual gives a list of suppliers of many of the ingredients shown in the sample diets, it also includes other useful diet related products.

2. Diet recommendation

For sturnids in general we recommend a diet that is pellet based with the addition of chopped fruits and vegetables. The amounts of meat protein and insects will depend upon the species and the species' preference. Meat and insect quantities should not constitute more than 10-20% of the diet regardless of the species. A pellet which is 14-18% protein, such as many parrot breeder diets, should suffice, with the birds obtaining additional nutrients from live insects and fruits and vegetables. Until further information becomes available about iron storage disease, we recommend a low iron pelleted diet.

Soaking the pellets makes them more palatable and digestible to most species. When soaking the water used should not be allowed to run off, as pellet nutrient levels change when fluids are added and then lost once the excess water is poured off. Water-soluble vitamins will be lost when excessive water is drained from the soaking pellets. Vitamins A, D and E are fat-soluble. Vitamin C is water soluble but not necessary for avian nutrition. Individual pellet integrity and water absorption capabilities will vary as each batch of pellets made by the manufacturer may vary slightly in density.

Diet ingredients may be fed separately on the same dish or mixed. If the ingredients are mixed, or stirred, the birds are more likely to ingest a balanced diet. The finer the ingredients are chopped and mixed, the more likely the birds will get a greater variety of the items fed. Sturnids are adept at picking through a dish of food and eating preferred items, making it difficult for them to get a balanced diet.

3. Water sources

Fresh water must be provided daily. Many mynah species, and some starlings, bathe every day. Some individuals, especially those that are tame or imprinted, appear to wait until their favored water dish is refreshed, immediately after which they will bathe often making it necessary to renew water sources twice a day. Many arid zone starlings prefer to rub against wet foliage, or will bathe in light rain or mist.

All species should be provided with a water dish 6 inches (14.4 cm) or more in diameter, and 1-2 inches (2.4-4.8 cm) in depth, which affords opportunity to both drink and bathe. Raising the food and water dishes above the ground is recommended, as this will limit contamination by rodents and other vermin.

Many aviaries in which sturnids are exhibited contain pools or streams. Superb and emerald starlings have been observed to bathe in shallow moving water (Congdon 1999) and most species will drink from this source of water making frequent cleaning necessary. Deep exhibit pools should have gradually sloping sides to reduce the danger of drowning, especially in a breeding environment where fledglings might be present.

4. Live food

Live insects are one of the favorite foods of most starlings and some mynahs. These should be fed in moderation outside of the breeding season and increased in quantity and variety while birds are raising chicks. During chick rearing some starling pairs are known to ignore all food items other than insects. Live food is essential for chick rearing by most species. Absence of live food in the chicks' initial days of life will likely cause them to die.

Depending on the species, consumption of animal protein during the non-breeding season may be rather limited. During the breeding season, however, all sturnids will consume large portions of animal proteins in preparation for breeding and feeding of their young.

Insect consumption should be limited as overfeeding can cause nutrient imbalances. Mealworms and crickets (and other insects with exoskeletons) contain relatively little calcium and fairly high levels of phosphorous (Brue 1995). This, coupled with the same deficiency in fruits and many vegetables, creates a dangerous imbalance of calcium and phosphorous. To correct this, insects should be fed a high-calcium food to "gut-load" them. They may also be coated with a high-calcium supplement. A commercially manufactured diet, high in calcium, is made for crickets and can also be fed to mealworms. **Section G** of this manual **"Maintaining insects"** offers advice from the AZA Nutritional Advisory Group (NAG) on caring for insects and making them more nutritionally complete as feed supplements.

5. Newly imported birds

All newly imported/wild-caught birds, should be provided with as much food variety as possible until they are well established. Food items can then be gradually reduced, while increasing the proportion of commercially made diet to simplify feeding and to insure consumption of a more balanced diet.

6. Method of feeding

Feeding sturnids is not difficult. Naturally curious and active, they will soon have investigated the far corners of their habitat.

When first introduced to a large aviary it is advisable to offer the birds numerous feeding sites. Placing feeding platforms in open areas at opposite ends of the enclosure and perhaps in the middle will help the birds find food more easily and identify how and where food should be presented.

A fresh supply of food must be fed daily. Twice a day may be preferred in warmer climates, as diets high in moisture experience rapid bacterial and fungal growth which can lead to infection and disease. By midday soaked pellets will also have lost much of their moisture content making them less palatable to the birds.

In mixed species aviaries multiple feeding sites help alleviate displacement and aggression. Once the birds have adjusted to their surroundings, and other aviary inhabitants, feeding platforms can gradually be moved to locations more suitable to both the caretaker and the birds.

Leaving the area beneath feeding platforms free of plants and other obstructions will allow easy cleanup of fallen food, which may otherwise attract vermin and become moldy. Removing all food dishes and cleaning under feeding platforms in the evening will also reduce rodent numbers and the snakes that feed on both them and birds.

Sturnids not only feed early in the day but opportunistically search for favorite food items, like insects and favored fruits, throughout the day. Enrichment items presented to the birds at midday while many zoo visitors are present will keep the birds stimulated and active, making them of greater interest to the observer.

7. Enrichment feeding

Many sturnid species will take advantage of challenging enrichment feeding strategies, especially those offering more insectivorous species insects and those more frugivorous a favored fruit. **Table N** reviews various enrichment ideas useful to sturnids and other bird species.

Table N. Enrichment Ideas
Juice and nectar feedings
Chunk fruit spiked on perching
Flowering or insect infested branches
Flowers
Sod or seed sprouted planters
Novell items (i.e. feathers, nesting material, toilet paper, etc)
Novell food items (i.e. pasta, rice, millet, toast, grains, beans, native insects, etc)
Dust, sand, or water bathing dishes
Nesting boxes
Foraging opportunities
Scattering insects throughout habitat
Trays containing coarse substrates, wood shavings, or detritus concealing food items
Vine ball containing insects crawling throughout
Large bamboo tubes (or PVC), with holes, for insects to escape
Pine cones with or without food (i.e. insects, peanut butter and seed etc)
Paper ball with food items inside

Starlings have rigid linear bills that provide efficient tools to remove, pry, and uncover concealed food items that they enjoy. Most mynah species have powerful cutting bills that allow them to tear into fruit and carve out bite size morsels. Searching for favored food items provided for them by their caretaker offers the birds' stimulus, making the resulting behaviors of greater interest to zoo visitors and of great benefit to the birds' overall well being.

Insects such as mealworms and waxworms can be fed in containers that regulate the rate at which they escape, such as bamboo poles drilled with small holes, which will frequently be visited by Sturnids. The more terrestrial African Sturnids are some of the easiest to enrich. They can be quickly trained to respond to a cue (such as jingling keys or a clicker) and will then forage for several minutes, usually within close proximity to zoo visitors and caretakers. Scattering highly mobile live insects, like crickets, on a routine basis will bring many species into closer proximity to their caretaker and the observer and also gives the birds several minutes of active foraging. Many frugivorous mynah species will also respond to a cue and will then investigate such food items as whole and chunk fruit. Both starlings and mynahs will often investigate nectar dispensers.

Other items of interest that keep the birds occupied are nest building materials scattered throughout their habitat. Bundles of grasses, coconut fiber, coarse cotton string, feathers, plant fiber, shredded paper, etc. will often pique their curiosity causing them to investigate. Reviewing **Tables I and N** will provide ideas of what may attract some sturnid species to the ground and into better view while eliciting natural and interesting behaviors.

G. Maintaining Insects

1. Insect Care

Many, if not most, of the members of the sturnid family, especially the starlings are highly insectivorous. Nearly all sturnid species should be fed larger quantities and varieties of insects during the breeding season when chicks are being fed. It is inevitable that a bird keeper will also become a caretaker of insect colonies. Maintaining healthy insects is quite easy and will directly effect the health and well being of adult and young birds.

Crickets, wax moth larvae (waxworms), and large and small mealworms are the most commonly fed insects to captive birds. Caring for these insects is simple and is similar for all varieties. For the more mobile insects, crickets and mealworms, smooth sided bins will best keep them contained. A bin with a depth great than 16 inches will prevent crickets from escaping. All can be maintained at room temperature if fed out within a week's time. It is recommended to refrigerate waxworms and mealworms and to freeze crickets if they are to be fed out over a longer period of time - the next topic, "gut loading", will explain why.

2. Gut-loading insects

To make insects more effectively nutritious for birds it is easy to "gut load" them by feeding the insects a diet fortified with ingredients that are beneficial to the birds and passed on to them by the insects. Commercially produced high-calcium diets for insects are recommended, as these with provide valuable calcium which is contained in food items not often consumed or included in Sturnid diets. Marion Zoological, Purina Mills, and Zeigler Brothers offer such diets for mealworms and crickets. Refer to the **Diet Item Resource Guide** for supplier contacts for insect diets.

Insects should be allowed to feed on the gut loading diet for at least 48 hours before being fed to the birds. This will increase their otherwise deficient levels of calcium. The high calcium diet should be the only food offered to crickets and mealworms. Water can be provided by placing a sponge or crinkled paper towel in the dish, this prevents crickets form drowning. The new commercially made "gel" water sources are also an effective means for delivering moisture to mealworms and crickets and an alternative to the above as some sources have reported the crickets eating paper towels or sponges.

Feeding bran, fruits, or vegetables to insects will dilute the gut load, making the insects less nutritious. Because the gut loading diet will not sustain insects, they should be fed to the birds within 7 days of being put on this diet. A higher incidence of insect die-off will occur if they are not fed out, or frozen for future use, within this 7-day period. It must also be remembered that if the insects are transferred to a different container prior to feeding, over a period of time they will defecate significant amounts of the gut load making them less nutritious.

Waxworms can be easily kept in a glass jar with a cheesecloth cover or plastic container with holes cut in the top. If kept in a refrigerator the transformation to moths will be delayed and nutrient levels will be more effectively maintained. A mixture of 12ml honey, 21.3g high protein baby cereal, 5.7g calcium carbonate, 10ml glycerol, and 4ml water may be fed to wax-worms if you intend to gut-load them.

H. Reproduction

1. The Captive Environment

Numerous variables affect the probability of success with any pair of birds. Nutritious diets, a predator free environment, favorable nesting sites, ample supplies of insects for chick rearing, and other conditions that might enhance reproductive success do not always persuade captive birds to breed. Lack of breeding may to be the result of behavioral/social conditions. The graph in **Table O**, taken from survey data, shows the number of years that birds have been in captivity before they have bred. (The lower number of years, seen in the wild caught golden-crested mynahs occurred among a flock of 3.3 birds housed in a large planted aviary). Housing sturnids in mixed species aviaries compounds and exaggerates many variables. Some of the positive variables are those mentioned above, with additional opportunities for the birds to select their own mates when kept in a flock. Although there appear to be many factors that would persuade pairs to breed, many are offset in large mixed species aviaries. Disturbances may be caused by displacement by other birds in general or at feeding sites, inability to find suitable territories, or by the frequent invasions by humans and other birds once a nesting territory has been established.

Mixed species aviaries have been described as "sacrificial altars to public display" when it comes to exhibiting birds.

Improved success breeding sturnids has been achieved when the birds are housed one pair per aviary. Survey data reveals that single pairs maintained in recommended sized aviaries, with few other bird species, show the greatest reproductive success.

Most commonly available starling species are known to become aggressive toward other birds during the breeding season. If maintained in a large aviary, other birds have a greater area in which to escape from sturnids; if there is not enough space, some residents may have to be removed. Superb starlings and Sulawesi crested starlings (king starlings) *Basiliornis celebensis* have been described as two of the most aggressive species. At DAK a single sex flock (females) of superb starlings is managed on exhibit. This has greatly, but not completely, reduced interspecies aggression during the breeding seasons.

Table P. Seasons in which these species have bred in captivity (Question 6G)

Common name	*Species Name*	# Pairs reported / Seasons
Asian pied starling	*Gracupica contra*	**1 / Summer and Winter**
Bali mynah	*Leucopsar rothschildi*	**26 / Spring and Summer**
Black-collared starling	*Gracupica nigricollis*	**1 / Summer and Fall**
Emerald starling	*Lamprotornis iris*	**3 / Spring and Summer**
Lesser blue-eared starling	*Lamprotornis chloropterus*	**1 / Summer**
Golden-breasted starling	*Lamprotornis regius*	**14 / Spring, Summer, and Fall**
Golden-crested mynah	*Ampeliceps coronatus*	**4 / Spring and Summer**
Grosbeak starling	*Scissirostrum dubium*	**2 / Spring and Summer**
Indian Hill mynah	*Gracula religiosa*	**4 / Spring, Summer, and Winter**
Vinous-breasted starling	*Acridotheres burmannicus*	**Spring, Summer, and Winter**
Metallic starling	*Aplonis metallica*	**1 / Spring, Summer, Fall, and Winter**
Amethyst starling	*Cinnyricinclus leucogaster*	**2 / Summer**
Superb Starling	*Lamprotornis superbus*	**15 / Spring, Summer, Fall, and Winter**
White-necked mynah	*Streptocitta albicollis*	**1 / Summer and Fall**
White-collared mynah	*Grafisia torquata*	**1 / Summer**

Sturnids may breed at varying times of the year depending on your geographic location and the changing seasons. **Table P** shows the seasons in which many species have bred in captivity.

2. Determining sex

The most frequently used technique for sexing many Sturnidae species is DNA sexing through blood sampling. Sex can also be determined through DNA using feather pulp. Surgical sexing is also popular but more invasive than DNA sexing.

Few sturnid species are dimorphic: Amethyst starlings and wattled starlings are the only two species that are clearly dimorphic (although outside the breeding season male and female wattled starlings are virtually indistinguishable.) Some of the mynah species of the genus *Gracula* vary slightly in size, the males being larger, but geographic variation may play part in this, requiring that these birds be sexed by one of the already mentioned means.

A handful of authors have discussed the possibility of sexing some starlings by the color of the inside of the birds' beak, mouth, and/or throat (Lindholm 1994). Dr Fritz Merkel long ago found that European starling males have a fully black gape. He describes the female gape as pale, yellowish, pink, dusky, gray, but not black. He goes on to say that this holds for all starlings known to him in East Africa including the superb and Hildebrandt's *Lamprotornis hildebrandti*, which he handled often.

"From the time the eyes begin paling from juvenile dark the sex is apparent." Glossy starlings and the red-winged starling also show this. And Dr. Short of the University of Johannesburg, South Africa, feels that this may apply to a major portion of the more than 100 Sturnid species, or at least to the more or less typical starlings.

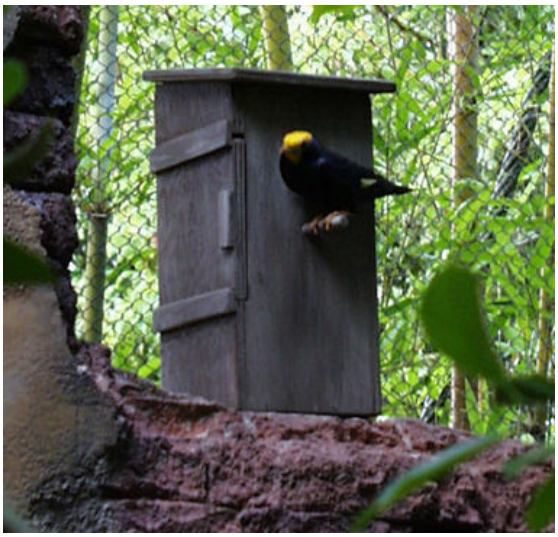
At Disney's Animal Kingdom we have tested this theory and found it to be true in some of the sturnid species available to us. Among these were the gold-breasted, emerald, superb, and wattled starlings. In some of these species the blackness extends less into the throat or more into the throat and less on the inside of the beak (Lindholm 1994). Grosbeak starlings and golden-crested mynahs show no noticeable difference in mouth coloration. This internal beak and mouth coloration is not likely an accurate indicator by which to sex mynah species as no literature was found that claimed this to be evident.

Slight variations in wing coloration and pattern have also been noted in the superb starling. The two rows of black spots on the secondary flight feathers are more distinct and larger from the outer edge inward on the male (Gibson 1994). The spots of the hen's lower row are smaller, and opposite to the male, the inner spots are larger than the outer ones. The male also has a very slightly wider and whiter chest band, best observed when the birds are sitting side by side. The wattled starling is the only species that has a different plumage during breeding season called nuptial plumage.

Until more comparative data is available, mouth and throat pigmentation and dichromatics must be considered unreliable in determining sex. Surgical, DNA, or feather pulp sexing are the only positive methods.

3. Nest sites

In the wild, starlings build nests in a variety of sites, varying from individual bulky nests of twigs in bushes and trees (such as seen in the superb starling), to massive communal nests built in bushes or even on the ground by wattled starlings (Laubscher 1995). Cavity nesting species vary in the site choice but most will utilize what is available including rock crevices, tree cavities, and human-made structures. A few sturnids make their own nest cavities, but more often rely on naturally formed hollows or those made by woodpeckers and psittacines. Some forest species will nest in epiphytic plants (Craig and Feare 1999). Most species build bulky nests inside cavities or will build bulky domed structures if building their own nest. Many captive sturnid species will accept a standard size cockatiel nestbox as a suitable site in which to rear their young.



Although most sturnid species nest in cavities in trees, nest building behavior is extravagant in some species and minimal with others. A few species breed in colonies and pairs share in nest construction and rearing young. The metallic starling *Aplonis metallica* nests in colonies, each pair building a domed circular nest hanging from the tip of a fine branch. There seems to be much diversification in the construction of the nest and the materials used. Wattled starlings have been reported in the wild to build massive communal nests in trees, in rocky cliffs, even on the ground. It appears that cooperative breeding occurs more often in African species and rarely in Asian species (Feare 1996).

4. Nest site recommendations

Table Q. Location of nest site in enclosure. (Question 5A) Pairs that have reproduced.	
Furthest from keeper entrance to habitat	32.00%
Furthest from public view	55.00%
Locatd in upper 25% of habitat	62.00%
Located in habiat's mid-level	39%
Located in the lower 25% of aviary	10%
Other	19%

A good plan for attempting to breed starling and mynah species in captivity is to provide as many variations in nest sites and nesting receptacles as possible. **Table Q** shows survey data describing the locations of the nest sites of proven pairs of sturnids and their proximity to human activity.

Typical cockatiel nestboxes seem to be popular. For cavity-nesting species offer several styles of nest box with sizes varying from 6" to 12" square at the base and 12"-30" in height. Nestboxes in excess of 10" in depth will require mesh ladders from the box entrance to the interior box floor to assist the birds in exiting the boxes. Nestbox entrances have ranged from 2" to 3" in diameter. Mynahs of the genus *Gracula* have been observed to use natural nesting sites in the wild with entrances that the birds have to squeeze through. None of the literature cited gives precise measurements for nest entrances while survey data showed that 80% of captive sturnid pairs used nests with entrance holes ranging from 2" to 3". The recommended nestbox size for the Bali mynah made in the husbandry guidelines, is a hexagonal box 30" long and 6" in diameter constructed of 1/2" or 3/4" plywood. The entrance should be 2"-2 1/4" in diameter. This design may also be found to be useful for other sturnid species.

Table R. Suggested nesting material taken from survey data. (Quest. 5R)	
alpaca hair	twigs
moss	feathers
willow leaves	grass
cambium	bamboo leaves
burlap	hay / straw
twine	dried oak leaves
yarn	pine needles
sheep's wool	green ficus leaves
mulch	llama hair
palm fiber	raffia grass
camel hair	paper litter
horse hair	wool

Nesting material normally consists of dry grass, straw or plant stems, rootlets, and other types of vegetation and detritus. **Table R** gives a helpful list of materials that might be provided for your birds for nest building. It has been observed that some species have a definite preference for certain nesting materials over others and may not be interested in some that you provide. **Table S** shows survey data describing what vegetation surrounds the nest sites of some breeding Sturnid pairs.

Nests are frequently lined with material other than the basic material of the nest. In captivity the nest cup will often be lined with softer materials such as grasses, feathers, green leaves, and coconut fiber. Feathers are a popular nest-lining component known to be used by superbs and golden-breasted starlings. Some African starling species, most notably the amethyst starling, are reported to use mammal dung in nest construction, while others have been observed to use mud. Green leaves, discussed at the end of this section, are used by many species to line their nests.

Leaves are also used among some species in courtship. The leaves most often used include ficus, small leafed oak, and pieces of palm leaves.

Table S. What vegetation surrounds the nest site? (Question 5B)		
None __ Sparse __ Heavy __ Nest site completely concealed__		
Common name	**Scientific name**	**Vegetation**
Asian pied starling	*Gracupica contra*	**Heavy (1)**
Bali mynah	*Leucopsar rothschildi*	**Sparse (30)**
Black-collared starling	*Gracupica nigricollis*	**Sparse (1)**
Black-winged mynah	*Acridotheres melanopterus*	**Sparse (1)**
Emerald starling	*Lamprotornis iris*	**Dense to concealed (3)**
Indian hill mynah	*Gracula religiosa*	**Sparse (4)**
Golden-breasted starling	*Cosmopsarus regius*	**None to sparse (16)**
Golden-crested mynah	*Ampeliceps coronatus*	**Sparse (4)**
Lesser blue-eared starling	*Lamprotornis chloropterus*	**None (1)**
Metallic starling	*Aplonis metallica*	**Concealed (1)**
Superb starling	*Lamprotornis superbus*	**None to sparse (16)**
White-necked mynah	*Streptocitta albicollis*	**Sparse (1)**

5. Courtship and copulation

Comparatively little is known regarding courtship behavior of most sturnid species. According to Sturnid survey data, of 54 breeding pairs 15 pairs (28%) were observed to display courtship type behaviors. Other than in the Bali mynah none of these behaviors were described. Courtship behavior reported in the common European starling involves wing-waving, chasing, squealing calls, and the close proximity of the pair to each other and the nest site (Stokes 1979). Similar behavior is seen in African starlings and possibly other sturnid species.

The Toledo Zoo has recorded courtship behavior when amethyst starlings were bred there. Courtship in each of two separately housed pairs involved "wing trembling" by females when males entered the nest site. Males were also reported to sing while the females carried nesting materials, and it was the dominant female that approached the male, who at the time of this breeding occurrence, were molting (Grigore & Michalski 1984). Females were also seen to "wing wave", a behavior in which alternate wings are moved in a slow waving motion. This behavior increased in frequency as actual nest building began. Wing waving was also described by Stokes as "long-distance advertising for a mate" in common starlings.

At Disney's Animal Kingdom (DAK) pre-copulatory behavior of grosbeak starlings has been observed involving the pair increasing shrill vocal intensity with bodies stretched rigidly parallel to each other. Soon the male was perched near the female and proceeded to flutter his wings while holding them slightly away from his body. During this time he made continuous grating and raspy vocalizations interspersed with sharp bursts of loud whistles, while hopping closer to the female. After being approached by the male several times, the female leaned forward and low on the perch, and allowed the male to step onto her rump as they briefly copulated.

Also at DAK a nesting pair of golden-breasted starlings was observed frequently carrying small green leaves throughout the enclosure several days prior to nest building. Early in this pair's formation the male was observed to approach the female by

climbing closer and closer to her and occasionally hopping. During this time his head was lowered, with throat close to the perch and beak up, with his head feathers compressed. The female was not observed to react in any way. Once this pair began actual nest building it was the female that did most, if not all, of the nest building. Using coconut fiber, pine needles, grasses and a large quantity of feathers she steadfastly built for 2-3 weeks. During this time the male was frequently observed carrying a single piece of nesting material in his beak as he followed the female to and from the nestbox. He was never seen to enter the box or to drop the material he carried. This routine of possible courtship behavior and nest building, with a nest and cup completely formed in the nestbox, eventually waned and stopped after about 5 weeks. Ironically no leaves were used in making this nest, a picture of which is included in this manual.

No additional descriptions of actual courtship and copulation have been found in literature searches nor in the literature cited. Because so little about courtship and pair bonding process in sturnids is known, it is important to gather and share as much information as possible. **Table T** reviews data describing the strength of pair bonds among sturnids. Nearly 70% of pairs are described as being strongly bonded, and perhaps follow-up study of these pairs would offer opportunities to document actual courtship behavior.

Table T. How would you describe your bird's pair bond? (Quest. 2D)
(Data from 47 pairs, 27 species, that have bred)

Pairs that have bred		Pairs that have not bred	
Loose	17%	Loose	24%
Strong	68%	Strong	26%
No sign of pair bond	9%	No sign of pair bond	40%
Nonexistant	6%	Nonexistant	10%

6. Eggs and chicks

Most sturnid species lay from 2 to 4 eggs per clutch, laid on consecutive days (in species for which records exist). Egg coloration among the family is nearly uniform: pale to medium sky blue or greenish blue, possibly with light brown or purple mottling or streaking. Incubation lasts from 12 to 14 days from the time the last egg of the clutch is laid. The nestling period varies by individual species but generally lasts from 19 to 22 days for starling species and up to 30 for mynahs, at which time the chicks leave the nest. They will continue to be fed by the parents for 10 to 14 days after leaving the nest before they are largely weaned. In some species the chicks will return to the security of the nestbox to sleep for the night (this has been reported to last up to 50 days in superb starlings). Occasionally chicks will fledge early or the youngest chick will fledge too soon along with older clutch mates. In these cases most parents have been reported to continue feeding these younger chicks which remain dependent for a slightly longer period of time after leaving the nest (Laubscher 1995).

In all but 3 African starlings, the wattled starling and 2 oxpecker species, the female alone incubates. In Asian starlings both adults incubate (Craig and Feare 1999). Among mynah species it is the female that does the incubating while the male roosts nearby (Naylor 1997). Most sturnid chicks, especially the chicks of the more terrestrial starlings and all of the mynahs, have comparatively long, ungainly legs and feet that bend easily until the bones have ossified (hardened). It is important that some sort of nesting material remain in the nest during chick rearing to avoid splayed legs.

7. Green foliage as part of nest building

Starlings and some other birds use fresh green foliage to line their nests. According to biologists some starling species use plants as pesticides, using specific plants to control blood-sucking parasites (Clark 1991). Some plant matter has been found to contain a volatile biochemical that

slows down or stops the growth of bacteria and kills arthropod parasites or otherwise reduces their populations in the nesting chamber (Clark and Mason 1985).

Fowl mites, often unknowingly present in bird collections, may parasitize the nestlings of some sturnid species (fowl mites have been reported in captive nests of golden-crested mynahs). Nests lined with fresh green plant material were found to affect the molting process of young mites, effectively reducing mite populations to levels that did not overwhelm chicks. Chicks raised in nests containing parasites and lacking green foliage often suffer from anemia and generally poor health (Clark 1991).

Table U. Species noted as using leaves in courtship or nest building. (Question 4E)

Common name	Scientific name
Asian pied starling	Gracupica contra
Bali mynah	Leucopsar rothschildi
Black-collared starling	Gracupica nigricollis
Emerald starling	Lamprotornis iris
Golden-breasted starling	Cosmopsarus regius
Golden-crested mynah	Ampeliceps coronatus
Grosbeak starling	Scissirostrum dubium
Vinous-breasted mynah	Acridotheres burmannicus
Superb starling	Lamprotornis superbus
Sulawesi king mynah	Basilornis celebensis
White-collared mynah	Acridotheres cristatellus

In captivity parent birds have been observed to add green leaves of ficus and little leaf oak throughout incubation and the chick rearing process. According to Clark and his colleagues, those plants studied and determined suitable to the birds and affective in controlling parasite populations are fleabane and carrot. **Table U** lists species from survey data that were observed to use leaves in nesting building or in courtship.

I. Hand-rearing

1. Techniques

Anyone that has raised birds knows that there are not always hard and set rules. Going with what works, but always searching for improvements, is a good rule of thought. Chicks are most often pulled from the nest for hand rearing in captivity due to parental neglect, disturbances from other bird species, or because of predator problems such as rodents. Fortunately chicks can easily be brooded in the traditional manner used for most captive altricial bird species.

Very little data exists with regards to hand-rearing most starlings and mynahs, although a good body of information is available about rearing Bali mynahs and a significant amount on hill mynahs. It is likely that most of the available sturnid species can be reared following the protocols set for these two species with regards to brooding parameters, and with the addition of higher protein and less fruit in the hand rearing diet. The Houston Zoo has had success in hand rearing emerald starlings and effectively did so by feeding the chicks the parental diet consisting of soaked Mazuri pellets, chopped fruits, insects, and chopped pinkies. Higher protein levels are necessary for proper chick growth and dipping food items into Pedialyte or water prior to feeding will also be necessary to maintain hydration. Emerald starling chicks were reported to be self-feeding and perching at approximately 21 days of age (Bailey 2000). Parent-reared superb starling chicks were reported to have fledged from the nest at 21 days (Gibson 1994). Some mynah species may not be self-feeding and weaned until 30 days (Nogge 1999). The weaning ages for these species gives us a good idea of fledging range for most species.

One of the most time saving improvements in hand raising mynahs was finding that chicks can be hand fed every one and one-half hours instead of every 30 minutes (Niznik 1997). This rate of feeding can most likely be applied to most sturnid species from hatch. The Bali mynah husbandry guidelines recommend feeding chicks at 2-hour intervals. Feeding guidelines for sturnid chicks would include beginning the chicks on chopped pinkies, crushed or chopped insects, and soaked commercial pelleted diet (parent birds' diet). The addition of varied fruit items would depend if the species is a frugivorous mynah or an omnivorous starling. Calcium

carbonate and vitamin supplements can also be added to the diet. To minimize problems with dehydration, food items should be dipped in dextrose or Pedialyte. As chicks grow, diet items can be increased in size.

The rate in which species develop and fledge will vary slightly. To reduce the level of human imprinting it is best to rear several chicks together and to avoid unnecessary human contact. Successful breeding of hand-reared Sturnids is well known among hill and Bali mynahs. Aggression toward conspecifics may be higher among hand-reared mynah species when compared to parent reared birds (Niznik 1997). Human imprinted Sturnids, setup for breeding, may have reduced fear of humans and therefore may approach or attack their caretaker if they feel that their territory is being invaded.

More information is needed to assemble detailed accounts of techniques used to hand-rear Sturnid species, especially starlings, as few exist. Data with regard to the effects of human imprinting need also to be collected so that this information can be shared and further recommendations determined. The topic of hand rearing and parent rearing of chicks is definitely one we intend to contribute to, as information becomes available.

2. Hand-rearing and Imprintation

An interesting observation by one mynah breeder (Niznik & Vinett 1997) is as follows: Two hand-reared birds were reared individually because they were single chicks. When they were mature enough to be placed with mates they were noticeably more aggressive.

It is not clear at this time what effect, if any, hand rearing has on chick development. It is known that some mynah species become more aggressive, when they mature, after being hand-reared and that some starling species show reduced signs of imprintation after maturing. It is important to carefully record the method of hand rearing and what exposure chicks have with the humans during the hand-rearing process.

J. <u>Capture and handling</u>

1. Trap cages

Trapping some sturnid species from large enclosures can be challenging. The greater the height of the enclosure the more difficult trapping becomes. Those species that are naturally more arboreal are likely to be to the most difficult to capture, while the more terrestrial species tend to be more curious and therefore easier to bait for and trap.

A permanent "howdy" cage incorporated into a large aviary will become one of its most important components. Introduction cages that are incorporated into aviary design serve both to gradually introduce species to their habitat and then as trap cages. More gradual introductions to other bird species and to habitats can be more effectively accomplished in spacious introduction cages. More space in these cages allows for greater flight distance for the new resident when the present aviary inhabitants come to inspect them more closely. Birds can also be maintained for longer periods of time in a larger environment in which they can exercise and behave more naturally. A larger introduction cage, big enough for the bird caretaker to enter, also makes servicing and managing its occupants more convenient. Giving the birds a greater area to fly in, and less likely repeatedly hit the walls, is another advantage of having larger introduction cages.

Becoming comfortable and familiar in the howdy cage during introductions may make the birds more likely to return to the cage and easier to capture when needed. Routinely offering food and water in a permanent introduction cage will also keep the birds in the practice of entering without suspicion.

It is best to always keep introduction cages conveniently operational. This most often implies that the bird caretaker of the area always has easy access to the closing trigger (i.e. string) that will shut the birds into the cage. Having a trap cage in the set position will allow you to

opportunistically trap birds that are not always easy to catch. Once caught weights, measurements, and physical examinations can be performed.

Those species kept in smaller aviaries can be caught quite easily using the variety of hand held nets available. Observing sturnid flight patterns during a hand held net catch-up one learns to anticipate their flight path making them easier to catch. Fortunately sturnid flight is relatively direct, when compared to some birds like laughingthrushes, which will often cover every inch of aviary space including the ground, before finally being caught.

Like most birds, once starlings and mynahs have been netted or trapped the more suspicious of their caretaker they become. They soon learn what nets are for and will recognize them when one is carried into the area. You will then have a more challenging time catching them. Sturnids will also become leery of baited trap cages and it may take several days for them to trust entering the cage again. It is a good idea to have an advanced plan of how to best capture your birds from their enclosures; without a plan both you and your birds will become stressed and frustrated.

2. Hanging trap cages

Smaller trap cages are easy to build and move about in a large enclosure when necessary. Cages 2-3' square can be hung from the mesh walls of enclosures using simple "S" hooks. A string attached to the door will allow the caretaker to hide a distance away. If a perch is placed inside, the birds may be more likely to enter. It may take the birds a few days to adjust to the presence of the cage but if food and water are placed within it is usually only a matter of time before they enter. The trigger door should be fixed open and food and water dishes should be placed in the cage each day. After a couple of days your string may be employed to keep the door open and then dropped once the bird of choice has entered.

3. Handling

The most favorable, functional, and safe technique for handling sturnids is in the same manner most medium to small passerines should be handled. The correct way to hold birds the size of starlings is to place the bird's head between the first and second fingers with the rest of the hand wrapped around the bird to contain the body gently but securely. The bird's back and wings should rest against the palm of your hand. The legs can be left free if the bird is calm. If the bird continues to struggle you may use you other hand to either secure the legs or allow the bird to grip your fingers with its toes. The accompanying photograph page shows effective handling and restraint methods. Once the proper technique has been learned for holding sturnids you will have relatively little difficulty in performing any task that involves their handling.

The bird is best held in the hand in which you favor, leaving the free hand to grasp the feet when necessary, inspect the wings, and even to open the bird's beak. A bird held with its neck between the index and middle finger allows near complete control of the specimen as well maneuverability by the handler. It is important to practice and feel comfortable holding birds as better examination can be made and reduced likelihood of injury.

After the bird has been captured it can safely be transferred into a pillowcase, or better yet, a small cloth bag. If neither is available it may be easiest and safest to carry the bird in the net and brought into a confined space at which time it can be removed from the net using the proper holding technique.

K. <u>Transporting, weighing, and banding</u>

1. Internal transportation of sturnids

Small birds like starlings and mynahs can be quite restless when placed in a carrier, therefore the best method for transporting them for internal moves is to place them in a pillowcase, or better yet, a small light cloth bag within a carrier (this is not a technique that should be used when

shipping birds by air or for extended distances). Placing them in a light cloth bag will keep them relatively calm and once placed in the carrier they are less able to flail about, potentially harming themselves. They will also be easier to remove from the carrier when your destination is reached. If using this bird bagging technique be sure to limit the amount of time the bird is kept in the bag and avoid potential overheating.

First place a towel on the floor of the carrier (the type of carrier typically used to transport cats for air travel works best). Place your bird, within its cloth bag, on top of the towel inside the carrier. If it is necessary to carry more than one bird at a time, especially if they are aggressive, it is a good idea to make ripples in the towel on the carrier floor and place the birds between these waves, therefore a bird biting blindly into its bag will bite into the towel rather than inadvertently biting another bird.

After medical examinations and anesthesia, birds can be placed back into their light and airy cloth bag and held upright to recover and regain consciousness; this also effectively reduces stress among small flighty birds.

2. Shipping sturnids

For journeys of long distances, driving trips, and air shipping, carriers recommended by the airlines for shipping pets are the best and safest to use. It is best to reduce the amount of light entering the carrier, which is helpful to relax and settle the bird for its journey. This is best accomplished by covering the mesh on the sides and door of the carrier with burlap or shade cloth. Pieces can be easily attached using plastic cable ties. The floor of the carrier should be covered with an absorbent substrate. A secure, low perch may be placed inside the carrier, but this is not necessary. (Long tailed sturnid species may avoid damaging their plumage if a perch is used). It is best to ship birds in separate containers or to place dividers within carriers, as birds frightened in a confined space may inflict injury upon one another.

3. Weighing birds

Knowing the bird's proper weight range often facilitates accurately assessing overall health and physical well being. Maintaining historical documentation of an individual species' weight from the time of its acquisition enables you the advantage of knowing whether the bird is within its normal, healthy range. Annual weighing and opportunistic weighing can be one of your best predictors for fitness. The chart in the apendix section gives the weights and weight averages of some of the more popularly held sturnids in captivity.

Capturing a bird for weighing should follow the same guidelines as found in the capture and transport section of this manual. Birds should be placed in a pillowcase or small cloth bag for weighing. Being loosely contained in a cloth bag keeps the birds more still and unable to thrash about or escape and fly into obstructions. Do not forget to tare or subtract the weight of the bag when weighing the birds in this manner.

4. Banding

All birds that become part of your collection should be banded. Banding birds on both legs will make identification quicker and therefore easier. Some birds are more capable at removing bands but are less likely to remove them from both legs. A bird's overall appearance is more symmetrical when banded on both legs and a past study of zebra finches has shown that mate selection criteria is inclined toward mate symmetry.

Band sizes will vary depending on the sturnid species in hand. The smaller species, such as amethysts and emerald starlings will take bands from 4 mm in diameter, for the medium size species a 5 to 6 mm band should do, and the larger species, such as hill and Dumont's mynahs, will need 6 or 7-mm bands.

Plastic bands will work well for the smaller species while metal bands should be used on the medium to large species as they have larger beaks or those more effective at prying. Numbers on bands are important for tracking parentage.

L. Veterinary Care

1. Heath and Ailments

The following is a list of reported sturnid diseases and associated signs. This list was compiled by reviewing existing literature and by discussing with institutions and individuals housing sturnids. Like most birds sturnids are often able to mask illness and associated signs of disease. Those specimens living in large planted enclosures often only allow brief glimpses of themselves, requiring that their caretaker be most vigilant for signs of distress. Those birds living in smaller enclosures can be observed more frequently offering quicker assessment. **Table V** describes those sturnid diseases reported in the survey data.

Table V. Incidence of sturnid disease, ailment, and death reported in survey data. (Quest. 9A)	
(Data from 117 pairs, excludes Bali mynahs *Leucopsar rothschildi*)	
Condition (Species in which condition was reported to occur acccording to survey)	**# of instances**
Parasites: Atoxoplasmosis, coccidia, gapeworm (Numerous species)	19
Hemochromitosis (reported in amethyst, golden-breasted, and gracula religiosa)	3
Asper (reported in superb starling and Bali mynah)	2
Metabolic bone disease (reported in among golden-breasted starling)	2
Egg binding (reported in golden-breasted starling)	1
Death caused by interspecific aggression (lesser blue-eared, purple glossy and superb)	2
Death due to intraspecific aggression (reported in golden-breasted starling)	5
Death caused by mammal predator	3
Death due to head trauma	3
Northern fowl mites found in nest box (reported in superb and golden-crested mynah)	3

2. Signs of disease

The following lists are possible warning signs to look for when assessing the health of a bird.

- Fluffed appearance where the body feathers are loosely carried
- Labored breathing occasionally accompanied by rhythmic tail-bobbing
- Loose or blood stained droppings
- Lack of droppings
- Loss of or reduced appetite
- Unusual perching or roosting location
- Sleeping during the day
- Half-opened eyes and overall lack of alertness
- Runny eyes or nares
- Vent feathers pasted with fecal matter
- Changes in fecal coloration
- Overall unsettled, frayed, and/or damaged plumage

3. Disease and parasites

If birds are showing any of the above signs, disease may be present. A physical examination, fecal analysis, and bloodwork may help detect the presence of parasites, infectious disease, or metabolic disease. The following is a list of commonly reported diseases.

Atoxoplasmosis: A protozoal parasite that often causes high fledgling mortality; it can also affect adult sturnids. Detected through blood work and fecal analysis. Although this blood

parasite may cause acute death, signs of infection include ruffled feathers, weight loss, and diarrhea. Efforts to eliminate the disease from birds are generally unsuccessful. Shedding of protozoa may be intermittent, and may increase during nesting. Some treatments can be successful. For treatment information refer to the Bali mynah protocol found at **www.riverbanks.org/aig/husband.htm.**

Coccidia: A protozoal parasite that can be detected by fecal analysis. Signs as seen in Atoxoplasmosis. Similar to Atoxoplasmosis in that birds may be chronic carriers of the disease for years without showing symptoms.

Capillaria: Nematode detected by fecal analysis or may be seen in the throat. Can affect the respiratory canals (throat and lungs). Signs as above and may also cause coughing and head shaking.

Ascaridia: Nematode worms detected through fecal analysis. Signs include central nervous disease, diarrhea, marked weight loss, and loss of appetite.

Cestodes: Tapeworms. Infrequently detected through fecal analysis. Signs of infection may be nonspecific indicators of illness.

Mites: External parasites affecting the skin and feathers. Signs of infestation include restlessness, overpreening, feather plucking, weakness, eventual weight loss and generally uncharacteristically poor plumage. Detected through very close inspection of skin and feathers. Use of a magnifying glass is very helpful. Most often easily treated, but may require thorough cleaning of enclosure as well as treatment of bird.

Hemosiderosis (iron storage disease): Caused by excessive iron accumulation. Signs noted in acute cases include trouble flying and walking, swelling of the abdominal area, chronic hepatitis with increased susceptibility to bacterial infection.

Salmonella: May be encountered in the cleanest environments because some birds may be chronic carriers. May occur more often in newly imported birds and after cross contamination of fecal matter and spoiled meat. Signs of infection are generally nonspecific indicators of illness.

Aspergillus: A pathogenic fungus affecting the respiratory system, including air sacs. May enter into other body systems. The onset of disease is often immunosupression associated with stress and may allow rapid proliferation of the organism.

As a rule, capturing birds for examination causes stress. If the bird's condition does not appear to be desperate, simply warming its environment, often effectively accomplished using a heat lamp, may help it to improve and recover. Often this will not be the case and the bird will need immediate medical attention at which times it is important to capture and transport the bird in a safe and effective manner. Helpful catching and handling techniques are described in the capture, handling, and transport section of this manual.

4. Iron Storage Disease

Hemosiderosis, the abnormal process of storing excess iron in the liver, and hemochromatosis, the disease resulting from the liver damage associated with the iron stores is a problem that afflicts some sturnids, most often the more frugivorous species. The pathogenesis is unknown but absorption and metabolism of dietary iron are felt to play a role in this process. This iron is stored in body tissues, especially the liver, which are damaged in the process. Eventually this stored iron leads to hemosiderosis and hemochromatosis (Vince 1996).

Because the disease process causes the liver to enlarge the most notable signs of hemosiderosis is difficulty breathing, flying, and walking. If left untreated it may eventually cause death. The

Bali mynah and the hill mynahs *Gracula sp*. are known to be two of the most susceptible to iron storage disease.

Iron storage disease was first discovered in the hill mynah and in the birds of paradise (Vince 1996). One of the principal causes of death for many of the 15,000 to 25,000 hill mynahs exported from India alone in 1979 (Sane 1983) is likely death stemming from this disease (Styles 2000).

Rates and levels in which iron is stored in the tissues and liver of other sturnid species is not presently known. To be safe the iron content parts per million (ppm) of pelleted and softbilled bird diets should remain low, to less than 200 ppm for starling species and below 100 ppm in mynah species. A study performed at the Brookfield Zoo shows that low iron diets (100 ppm) reduced the iron stored in the liver (Boyer 2000).

Table K reviews the iron levels found in a few of the more popular softbill and pelleted diets. Iron levels will vary with different batches of the same brand diet because iron in the ingredients can vary (Boyer 2000). Soil conditions that food crops are grown in can change in iron levels therefore, from crop to crop foodstuff iron levels will vary.

Final thought and Acknowledgements

The degree of success and knowledge that we have achieved in the captive management and husbandry of Sturnids can be attributed to dedicated zoos, zoo curators, aviculturalists, and especially, to bird caretakers.

Continuing to advance our understanding of starlings and mynahs we come closer to satisfying their husbandry, medical, and dietary demands. Gradually we will improve our husbandry success, recognizing that the process still involves trial, and with shared information, fewer errors.

Advancement occurs when experience and knowledge are combined and then shared, only then are we able to establish and maintain a productive population of birds that will ensure the future of these beautiful species in captivity.

A great many people and organizations are to be thanked for their help in preparing of this manual. We do not consider this project to be completed, as much information is still necessary if this family of birds is to increase its captive longevity. We look forward to the future and organizing a husbandry workshop for Sturnids and the further sharing of information.

Disney's Animal Kingdom's Curator of birds Grenville Roles was the initial enthusiastic supporter of this investigative effort, recognizing the lack of information available with regards to this dynamic family of birds. Zoological managers Chelle Plasse and Scott Barton helped by giving generously of their time and knowledge.

DAK research curator Dr. Jill Mellen and research assistant Kyle Burkes were also of tremendous help in designing the survey and assisting us in reading the resulting "pile" of data. Brainstorming with Dr. Mellen was especially exciting when developing tactics for generating

completed surveys and feedback from unresponsive curators (you may recall the “neon postcard assault”, hidden messages, and prize offerings-we blame all of this on her). We are happy to report that no one has made Santa's naughty list”.

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Thanks to all of the heroes and heroines in animal care that directly care for these splendid birds, recognize their characteristics and behavior and then translating that information onto the survey for us. We realize that putting pen to paper and sharing information by filling out a 4-page survey was no small task. You’re the best!

We are greatly indebted to everyone mentioned above for contributing various ways, all of you gave us the resources to complete this important project.

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Recommended journal publications

The AFA Watchbird- The Journal of the American Federation of Aviculture
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