In this issue

Penguin Husbandry 1
Penguin Banding Methods 2
Humboldt SSP Report 3
Penguins: from Maintenance to Management 4
Captive Reproduction: a Statistical Overview 8
Behavioural and Morphological Sexing 14
Directory of Institutions insert
From the Editor . . .

Survey Results

By mid-April, survey returns had come back from 80 of 117 zoos and aquariums to which they had been mailed in September. This very encouraging return rate (68%) has brought together a huge quantity of information on the make-up of the captive spheniscid population, and the details of its management: diet, reproductive success, physical environment, and so on. The data are now being put onto the computer for analysis. Two sections, dealing with the population and its reproductive history, have been compiled and some of the results are in this issue.

As promised, the first utilization of this information has been in compiling a worldwide directory of all zoos and aquariums reporting holdings of spheniscids. The directory, which is enclosed with this issue of SPN, summarizes the holdings of each institution and gives its address, telephone number, and the name of the individual who filled out the survey. We hope the directory will promote direct communication between institutions, and facilitate exchange of animals and information.

As we receive additional survey returns, we will update the directory to

please turn to page 3

Penguins are one of the most popular groups of birds displayed in collections. Most of us working with them know that keeping them alive and healthy, let alone promoting successful breeding has proven quite difficult. Suitable diet, compatible breeding pairs and stable keeper staff are some important factors in maintaining a thriving penguin colony. There is a wide range of techniques, methods, and resources available at different institutions.

EXHIBIT

The penguin colony at Woodland Park Zoo is composed of 44.3 Humboldt Penguins (Spheniscus humboldti) which are

please turn to page 10

Penguins seem quite adaptable to a wide range of practices and situations, or .... there is more than one way to raise a penguin.

African Black-Footed Penguins Available

Is your institution starting a new penguin colony, or do you want to enhance your present collection? The Steinhart Aquarium's prolific Black-Footed Penguin colony has provided us with several surplus juvenal penguins hatched in 1987, 1988, and 1989. Most are ready to ship immediately.

If you are interested, please call Karen Anderson, Aviculturist, at the Steinhart Aquarium in San Francisco, at (415) 750-7247, or write to:

Karen Anderson
Steinhart Aquarium
Golden Gate Park
San Francisco, California 94118
USA
Accurate record-keeping, an important basis of animal management, requires a reliable method of identifying individual animals. For penguins, this usually means wing-bands. In this review, various types of wing-bands—as well as several other methods—will be described, with their advantages and disadvantages. None of these is ideal, and there may well be methods used by some of our readers which are superior. On this topic, as on all the topics we discuss, we welcome information, questions, and observations from readers, so that we can all benefit from each other’s experience.

**GENERAL CONSIDERATIONS**

All wing-bands are put on the penguin’s flipper right next to the body. Care must be taken that the bands are not too tight, since restricting circulation can cause serious injury. During the molting period, when flippers swell somewhat, bands must be checked carefully and removed if they become too tight. With experience, staff can learn just how much looseness to leave in bands so that they will not come off, yet will not become too tight during molt.

Visibility, durability, and ease of application are important criteria for any identification method, but the importance of each factor may be different in different institutions. For example, when a group of penguins are not closely approachable, or when behavioral observations are desired, it will be preferable to choose bands which are easily distinguishable from a distance. For a small group of penguins, or a group whose members can be identified by their behavior (nest site, pair bond), loss of a band is not disastrous; for a different group, it may be advisable to use the most durable bands possible, and band all individuals on both flippers or use other means to ensure positive identification of a bird which loses one band.

Some zoos use bands to convey additional information besides individual identity. Where colored bands are custom-made in the institution, a color code can be used to denote year of hatch, parentage, etc.

**TYPES OF BANDS**

**Cable ties**

In an informal survey of a number of US zoos, by far the most commonly used band was one based on self-fastening plastic “cable-ties” which are sold by electrical supply houses for the purpose of binding together bundles of electrical wires. (Specific information on this, and other products mentioned, follows the article.)

Cable-ties are narrow plastic strips, available in various widths (from about 1/8 inch [3 mm] to one inch [2.5 cm]) and various lengths, from eight inches [20 cm] to fourteen inches [36 cm]. They are made of an extremely tough plastic which is virtually immune to wear and breaking. Colored ties are available, but usually only in large quantity, so often white ones are used and colored elements added. For a commonly used size (1/4 to 1/2 inch wide [6 to 12 mm]), the cost is about $2.50 for 100 ties.

Each tie has a small plastic, or plastic and metal, fastener at one end; the other end of the strip is ribbed in such a way that it will only go through the fastener in one direction; once it has been pushed through the fastener, it cannot be loosened. The easiest way to apply a cable-tie wing-band is by first starting the free end through the fastener to produce a loop large enough to pass easily over the bird’s flipper; then, after placing it on the bird’s flipper, it can be tightened as desired and the excess (free end) cut off, as close to the fastener as possible to avoid having a sharp end sticking out. Due to the design of the fastener, if a band is accidentally tightened too much, it must be cut off and discarded, but experience soon makes this a rare occurrence.

These ties are favored due to their great durability and ease of use. They do not cause wear on the feathers beneath the flipper.

Two methods of color-coding these bands were used by zoos contacted. In one, colored plastic mending tape is tightly folded around the section of the tie nearest the fastener. The tape will not pass through the fastener, so the colored portion must be made just a little less than the circumference of the loop around the flipper; a used band can be measured for length, and colored tape applied to that length of tie. Plastic tape lasts longer than fabric-based tape such as library mending tape. Solid colors are the most durable, but stripes can be used also, when the number of birds exceeds the number of colors available. When the tape is carefully put on, it will last from a few months to a couple of years; eventually, wear and abrasion will cause it to chip or peel off.

A more sophisticated way of color-coding uses additional colored plastic ties, in a very narrow size. These ties are looped tightly around the band itself and the excess is cut off, leaving the fastener and cut end facing outward so that they are visible and do not rub against the bird when the band is applied. The colored ties are like colored beads on a string conveying a coded message. Ten colors of narrow ties are available, so that each color can stand for a numeral; red/red/yellow can stand for 116, bird #116, for example.

Each of these coloring methods has its advantages and disadvantages. The colored tape is highly visible even at a distance and less prone to confusion than the coded series of colored cable ties; however, the cable tie “beads” are more durable than the plastic tape.

**Hospital ID Bands**

Some zoos have tried making wing bands using the very flexible plastic bands which hospitals put on patients’ wrists. These are easy to apply, and may be available in a limited range of colors (or can have colored tape added), but have generally been rejected because of poor durability.
Memorandums of participation in the Humboldt Species Survival Plan (SSP) program have been received from seven institutions that are currently holding Humboldt penguins, and non-member applications for participation in the SSP have now been received from two institutions. One additional institution that has a small population of Humboldt penguins has been located and will be contacted about participating in the SSP. Two institutions holding Humboldt penguins have not yet responded with signed MOP’s.

The SSP propagation group met officially for the first time at the American Association of Zoological Parks and Aquariums (AAZPA) meeting in Milwaukee on 23 September 1988. At that meeting a studbook report was presented by Steve McCusker. Steve announced his intention of publishing one studbook update and then relinquishing the studbook keeper position, since he is no longer managing Humboldt penguins at his present institution. A new location for the studbook was discussed; the propagation group agreed that Brookfield Zoo should apply for the studbook when McCusker’s term is finished, in accordance with the request from the Wildlife Conservation and Management Committee (WCMC) that whenever possible both studbook and SSP be organized from the same institution.

Historical print-outs of Humboldt populations at each institution were distributed; representatives were asked to verify all information contained in these printouts and advise the studbook keeper of any corrections. Before data from the studbook can be effectively used for SSP population management, it is highly desirable to have all studbook data verified. There are a number of wild-caught individuals in the studbook for whom estimated birthdates have not yet been assigned; in order to make the best use of various of the population management programs we will be trying to assign birth dates that are the best approximations possible.

Dr. Bob Lacy, population geneticist from Brookfield Zoo, discussed a request for blood samples from as many individual Humboldt penguins as possible. The goal of the research is twofold: a student working with Bob will be looking at differences among the Spheniscus species, and Bob’s lab will estimate genetic diversity in the wild-caught birds in captivity and will track levels of diversity as captive-hatched birds of successive generations are produced. Protocols for taking and submitting the blood were discussed. The propagation group agreed to support the research request and to provide blood on an opportunistic basis as birds are handled for management reasons.

It appears that there are at least two problem areas for which more complete data are needed to give us better insight into management. Reproductive failure seems to be recurrent in the population and may be expressed in both hatching failure and chick mortality. In addition, there seems to be mortality associated with shipping birds to new locations, and causes of that mortality must be examined. A survey specifically addressing these two major areas of concern has been sent to the participating institutions.

Finally, because some of the challenges of working with Humboldt penguins seem to be very similar to those encountered with Black-footed and Magellanic penguins, it was suggested that an official Spheniscus working group be proposed for endorsement by WCMC.

From the Editor, cont’d from page 1

include these additional institutions, and will include their data in the analysis of penguin reproduction, management, etc. So, it is never too late to fill out and send in that survey (but the sooner the better!). Blank copies of the survey are available upon request.

The responding institutions vary greatly in nearly every respect. Some keep only a handful of penguins, others have dozens; some must make due with very little staff time for penguins, others are able to give more intensive care. Similar variations occur in respect to record-keeping, ongoing observation and research, dietary supplements, nesting arrangements, and so on.

In order to be useful to readers in this variety of situations, this newsletter will seek to present articles setting forth a wide range of approaches, from the pragmatic to the sophisticated. Each institution has evolved methods which work well in its situation, and they may or may not work in other situations—there is no “cookbook” with universal recipes—but there is much to be learned from each others’ experiences and observations. SPN’s readership also includes many individuals who are involved in field work or conservation, and we value their interest and contributions. Exchange of information between those working in the field, and those working in zoological institutions may often be illuminating to both.
Penguins in Zoos: Progression from

by Sue Ellis-Joseph

Maintenance of any animal species in captivity requires consideration of a multitude of factors ranging from a species' behavioral and environmental needs to dietary requirements and medical considerations. Once simple captive maintenance of a species progresses to propagation of a species, additional factors of preservation of genetic diversity and demographic planning become important as well.

Programs for scientific management of captive populations generally consist of three kinds of components: demographic, genetic, and behavioral-ecological (Foose, 1978).

Demographic components operate with information of age and sex structure of the population, survival, and fertility. This information can be used in management programs to specify the numbers, ages, and sexes of animals that are to be retained in or removed from the population, as well as the number and ages of animals that should be bred and number of offspring produced to attain and maintain a stable population (Foose, 1977). These data can indicate how to attain and maintain a population stable in numbers and age distribution at some desired number, or the "carrying capacity" for that species (Foose, 1978). The ultimate carrying capacity of a population would depend on a compromise of several criteria: the status of the species relative to others in the wild; the financial and logistical resources of the institutions involved; and scientific considerations, particularly those relating to genetics (Foose, 1978).

Genetic components use information about the ancestry of individuals to refine the demographic programs, by recommending breeding plans. These plans are designed to minimize inbreeding (i.e. breeding of related individuals, leading to a substantial decrease in genetic variability) and genetic drift, an unsystematic change in gene frequency from one generation to the next (Bouman, 1977; Flesness, 1977; Foose, 1978; Plomin, DeFries & McClearn, 1980). Inbreeding can be minimized by planning matings of least related individuals; genetic drift can be reduced by maintaining as large a population as possible with as much equality in the sex rations and family sizes as is feasible (Foose, 1978).

The third element in the scientific management of captive populations consists of behavioral-ecological components, such as veterinary care, general husbandry, psychological well-being, nutritional considerations, and other factors. These act to create captive conditions conducive to survival, reproduction of individual animals (Foose, 1978), and normal development and expression of species-typical tendencies.

For most penguin species, genetic and demographic planning have not been particularly strong in zoological institutions. This is due in part to the fact that only within the last decade has reproduction in captive penguins become common, and in part to relatively recent emphasis on maintaining systematic records for penguin collections. These recent developments, as well as others, have now set zoos on a course away from merely maintaining penguin species, and toward actively managing reproducing zoo populations of these birds.

Steps toward active population management generally take place in a logical progression, beginning with establishment of a founder population (those individuals starting the population), through multigenerational breeding, and eventual out-breeding (breeding with animals in other institutions). Important here is the shift in focus from individuals in one zoo to whole species populations in all cooperating zoos.

Zoo geneticists point out that for any population of animals, the number of individual founders may not be as important as their subsequent cooperative management (e.g. Senner, 1980; Foose, 1983), and that for many species five to ten pairs of carefully selected and well-managed founders are likely adequate. To enhance the chances for a successful captive breeding program, two rules are vitally important: 1) avoid starting a population with already inbred animals; and 2) avoid starting a population with related animals (Senner, 1980). Acquisition of animals for a new population—when a zoo begins a new program—should be performed carefully to minimize relatedness between founders.

Without careful management, a reproducing zoo population, which tends to be fairly closed, is in danger of becoming inbred. Inbreeding occurs when related animals reproduce together, often with eventual deleterious effects ranging from reduced fertility to reduced viability of offspring and/or genetic defects. One of the best means by which the potential for inbreeding can be reduced is by carefully planned, periodic exchange of individuals between institutions.

Presently, only the captive Humboldt penguin population is earmarked for cooperative and global management with genetic and demographic considerations in mind. Within the American Association of Zoological Parks and Aquariums (AAZPA), a Species Survival Plan (SSP) is being formulated for Humboldt penguins, which will lead to better managed and carefully chosen groupings of birds. The inbreeding potential for this highly endangered bird will thereby be reduced. For Spheniscus penguins, an interest group is being organized within AAZPA, and SSP's for other species will probably be developed in the future.

For birds not currently managed under an SSP, institutions can begin on their own to take steps toward better management. Critical practices are:

1) Identification of individual birds. This first step is also the most important step. Identification is best accomplished by banding. Especially in large colonies, banding on both flippers is recommended to that the accidental loss of one band does not preclude identification. Both adults and chicks should be banded. Chicks can be banded with simple colored embroidery thread which can be loosened as flippers grow, and replaced with a permanent band once chicks reach adult size.
Maintenance to Management

2) Maintenance of good records. Types of information that are important include:

A) Attempted and successful pairings.
* identity of pair members
* dates and times of copulation (if possible)
* dates of laying, hatching, and fledging of offspring
* information on the disposition of unhatched eggs (e.g., infertile, addled, lost, etc.)

Recording this information is especially important for genetic aspects of management, and allows calculation of relatedness of any offspring produced, as well as reproductive success of pairs, mate fidelity, fidelity as it relates to reproductive success, etc.

B) Location of nest sites.

Recording of this information yields data on nest site fidelity year to year, and in conjunction with the information gathered under A, sheds light on the relative success of different sites, inter-nest spacing, etc.

Both A and B can easily be accomplished on a large gridded-to-scale map of the nesting area (Figure 1). Sites can be drawn in as they are established, and pertinent data recorded directly on the map as it occurs. At the end of a breeding season, these data can be easily summarized from the map and compared year to year.

C) Medical and nutritional information on individuals and the group. This should include any conditions for which an animal is treated by the veterinary staff, and any changes in diet or vitamin regime.

3) In-house genetic management. The first two steps make possible the third. An interesting and useful way that genetic history can be recorded is by drawing pedigrees for each bird (Figure 2). By knowing which animals are related, breeding between related animals can be discouraged. Unlike mammals, birds can easily be prevented from reproducing by not allowing eggs to be incubated. Alternatively, if space allows, one member of a pair might be isolated with a genetically desirable mate to encourage a new pairing. Further reproduction in birds that may already be over-represented genetically (i.e., those birds with a disproportionate number of offspring) in the population can also be discouraged in this way. Also, it is possible to foster eggs or chicks from one pair to another, when the two pairs are fairly synchronized in their reproductive cycle. Thus, a pair which is already over-represented might be allowed to raise a chick from an under-represented (and perhaps less experienced) pair, which can then concentrate on raising their one remaining chick.

please turn to page 6

Figure 1. Gridded map of a penguin exhibit. Nests (shown as circles) and identity numbers or band colors of pair members, as well as laying dates, can be recorded directly on the map, and transferred to summary sheets after a breeding season is completed.
Figure 2. Sample pedigree of one Humboldt penguin (Red/Orange Right) at the Washington Park Zoo. This is one of several ways to keep track of lineages. Summaries such as this aid in determining which birds are related to one another (to avoid inbreeding), and in tracking the reproductive success of the various pairs. By convention, the male of a pair is shown upper line (e.g., Red Rt.).

4) Inter-institutional cooperation. Working with birds of known origin and relatedness allows better-informed exchange of animals between institutions, discouraging inbreeding and greatly improving gene diversity by improving gene flow between zoo populations.

Ideally, these practices should be incorporated into the initial establishment of a zoo population. Realistically, a recent survey of Spheniscid penguins has indicated that in many extant zoo populations, individual birds are not banded or identifiable, and record-keeping practices are minimal. This is unfortunate, but not hopeless. For such institutions, the first step is immediate implementation of management practices outlined above. Regrettably, some birds will remain of unknown origin, but at least they can be identified, banded, and their activities followed in the future. (Zoo-bred animals of unknown parentage are usually excluded from mainstream breeding as SSP's are developed, but identification of all individuals in a population is a necessary first step.)

With responsible action now, we can work toward ensuring that future generations of penguins are managed thoughtfully by all facilities that hold them. Implementation of the practices discussed above provide a solid step in that direction, and will be of great import as SSP's for all Spheniscid penguin species become a reality.  

REFERENCES


Rigid Plastic Bands

At least one zoo has used bands made of a double-layer plastic, a colored layer over a white layer, with identification letters or numbers engraved into the surface so that the white underlayer shows through. This plastic is fairly rigid, and must be shaped to fit by using a combination of heat to make it flexible, and cold to set it. Pliers are used to bend the material over a prepared form of the desired size. Holes are made in the ends and a small nylon nut and bolt used to fasten the ends together when in place on the flipper. The nut and bolt can be further secured with glue to keep them from working loose.

This band is fairly durable, though less so than the cable ties. The rigid plastic may crack (especially in cold temperatures), or the nut and bolt may break. The pieces of hard plastic resulting from breakage pose a hazard to penguins which may pick them up and eat them. These hard bands also cause worn areas underneath the flipper in some cases. For these reasons, the zoo reporting use of these bands has reduced their use and is seeking better alternatives.

Implanted Transponders

Electronic technology has provided a system, used extensively for identifying race horses, which Sea World of San Diego is using as a back-up ID system for their penguins. A tiny transponder (about the diameter of a pencil lead) is implanted subcutaneously, in the back of the neck, using a hollow needle. Each transponder has its own unique 10-digit alpha-numeric code, which is "read" by passing a hand-held device over the back of the neck.

Sea World has used this system successfully with adult emperor penguins and king penguin chicks, and hopes to expand it to other species. Thus far, there have been no problems with infections (from injecting the transponder) or migration of the transponder from the site of injection.

This system fills a unique place in the range of identity systems: it does not give you any information unless you are standing right next to the bird with the reading device in your hand, so it is not helpful for observations or record-keeping. But it does provide what no other system can: permanent identification of an individual during its life (and even when dead). As an ID system, it would be valuable as a back-up—to identify an individual despite lost bands or wrong bands—and as a permanent form of ID for birds which go from one institution to another. The penguin banded Blue-White Right in one zoo may become Band #116 at another, but its transponder code would always be the same.

The system's drawbacks are the initial expense of acquiring the equipment: syringes, transponders, and reading devices with battery packs.

Identifying Chicks

Chicks in the nest, too small to have regular bands, can be marked with harmless dye (such as food coloring) on one flipper, or by colored thread tied around a flipper next to the body. The hospital bands mentioned earlier might be usable on chicks, since they would not be subjected to as much wear as when used on an adult, and the length of time they must last would be short. If used, however, they should be checked and replaced if necessary, to avoid loss and possible ingestion.

When young penguins are close to fledging and leaving the nest, regular bands can be applied. By the time the juvenile molts the following year, this first band may well become tight and need to be replaced.

PRODUCT INFORMATION

Plastic cable ties are commonly available from electrical supply houses. They are made by several US manufacturers, including Panduit Corp., Tinley Park, Illinois 60477-0981. Phone (612) 993-2594. Sample sizes used by one institution are: large size, for basic band—PLT45-M, 14 1/2 inches (368 mm) in length and about 1/4 inch in width; smaller ones to be used as color-code "beads."—PLT151-M, and PLT1M-M3.


Cynthia Cheney
Washington Park Zoo
Portland, Oregon USA

Selected Abstracts


Abstract: The concentrations of vitamins A and E in the plasma of captive jackass penguins was studied in birds fed defined quantities of the vitamins. For a year, each of the 17 adult birds in the colony received a daily diet of 340 g of sprats and a vitamin supplement tablet, together providing 2.04 mg per day retinol equivalent and 185 mg per day alpha-tocopherol equivalent. The concentrations of plasma retinol and alpha-tocopherol and the alpha-tocopherol/total lipid ratio compared well with those recorded in wild populations of related species of penguin and the birds moulting and bred successfully.
In examining data from the SPN survey returns, one of our first concerns was the success rate of spheniscid reproduction in zoological institutions. The table below summarizes the information from returns received thus far, and show some interesting patterns.

The total reported populations for the two most numerous species are nearly equal: 599 individual Humboldts, and 583 Blackfooted penguins. 149 Humboldt pairs have laid eggs at some time, compared to 135 Blackfooted pairs. But the number of pairs which have ever successfully reared chicks to fledging is quite different: 49 Humboldt pairs, and 106 Blackfooted pairs.

Table 1. Summary of populations and reproductive activity at reporting zoos

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<th># females</th>
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<th># pairs laid</th>
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<td>32</td>
<td>11</td>
<td>34%</td>
<td>3</td>
<td>0</td>
<td>0%</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

Key to abbreviations used above:
- # pairs laid: number of pairs which laid eggs in most recent breeding season
- # bonded pairs: number of pairs which are bonded, regardless of reproductive activity
- # pairs fledged: how many pairs have ever raised a chick to fledging
- PR: Parent-reared
- HR: Hand-reared
- % PR fledged: of the chicks which were left with parents, what percentage survived to fledging
- % HR fledged: of the chicks which were pulled for hand-rearing, what percentage survived to fledging
a statistical overview

This historic pattern is still seen in the figures for the three most recent breeding seasons. In 1987/8, for instance, 72% of Blackfooted pairs attempting to rear chicks were successful, rearing at least one chick to fledging. For the Humboldt pairs, only 41% had success. The handrearing success rates are reversed: 82% success in handrearing Humboldt chicks, and 26% with Blackfooted chicks. (Perhaps, since Blackfooted penguins seem to do so well themselves are rearing chicks, institutions tend to hand-rear mostly chicks that are doing fail to thrive, thus starting with an unrepresentative sample of chicks.)

Next we must ask, are the different results for parent-rearing success characteristic of most of the zoos, or just the result of dramatic success or failure at a few institutions?

Table 2 shows figures for each zoo reporting parent-rearing success. The columns list how many chicks at each institution were fledged by parents, and what the percentage of success was. With Blackfooted penguins, only one zoo had less than 67% success; with Humboldts, poor results are more frequent.

Table 2. Parent-reared success rates, by individual zoo (1987/8)

<table>
<thead>
<tr>
<th>Zoo</th>
<th>Surviving parent-reared chicks</th>
<th>% of success</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>40</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>G</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>H</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>I</td>
<td>7</td>
<td>88</td>
</tr>
<tr>
<td>J</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>K</td>
<td>2</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zoo</th>
<th>Surviving parent-reared chicks</th>
<th>% of success</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>4</td>
<td>67%</td>
</tr>
<tr>
<td>M</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>N</td>
<td>31</td>
<td>100</td>
</tr>
<tr>
<td>O</td>
<td>37</td>
<td>50</td>
</tr>
<tr>
<td>P</td>
<td>3</td>
<td>63</td>
</tr>
<tr>
<td>Q</td>
<td>9</td>
<td>82</td>
</tr>
<tr>
<td>R</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>S</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>T</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>U</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>V</td>
<td>4</td>
<td>78</td>
</tr>
<tr>
<td>W</td>
<td>4</td>
<td>80</td>
</tr>
</tbody>
</table>

This apparent inability of Humboldt pairs to raise chicks could result from many factors: diet, size of colony, nesting facilities, and so on. Continuing analysis of the data will, we hope, provide some clues.

Still, the information indicates that success is possible for both species, with both methods of chick rearing, and the exploration of factors important to success will of course be a major focus of this newsletter. In analyzing the survey data, we will be looking for correlations between reproductive success and various management factors such as diet.

Hand-rearing and parent-rearing each have their advantages, and advocates. Circumstances at a particular zoo may make one method particularly preferable. At some zoos, hand-rearing has been systematized and highly successful protocols developed. Parent-rearing, by its very nature, is not under close human control and observation, and success factors may be harder to determine.

Hand-rearing has the advantage of being controllable, generally yielding good success. For spheniscids it does not, as with some animals, produce young unable to socialize and reproduce normally; very few zoos reported hand-reared birds which did not show normal social and sexual behavior by the fourth year. However, the following negative considerations do apply: hand-rearing is labor-intensive and may be impossible at some institutions due to staffing limitations; hand-rearing deprives pairs of their normal parenting activity, and in some situations may cause repeated re-clutching, putting a physical strain on the female's system, and putting the pair out of synchronization with the annual breed/incubate/rear/moult/rest cycle.

Whichsoever method of chick-rearing is used, our priority is to maximize success, particularly with wild-caught birds not yet adequately represented by offspring. Some factors influencing success may be beyond control: the age of a given pair, for instance, or some features of an exhibit structure. But most factors lie within the realms of husbandry and management; our task is to determine the importance of these various factors, by examining our own experiences, and learning from those of others.

Cynthia Cheney
Washington Park Zoo
Portland, Oregon USA

Weighing an 18-hour old parent-hatched Humboldt chick.
[Photo by Max Gutierrez, Washington Park Zoo]
displayed in an exhibit that formerly housed seals. The pool has a 155 foot (46.4 m) circumference with a 15 foot (4.5 m) wide circular moat and a 20 foot (6.0 m) diameter island in the center. The water is 7 feet (2.1 m) at the deepest point giving the colony a large water volume for bathing, diving, and porpoising. Adjacent to the pool, the colony has access to a small holding area with two runs each measuring 42 inches (105 cm) wide by 82 inches (205 cm) long. The interior is heated to 60-70°F (16-31°C). The exhibit is cleaned once a week with a small 54 pound (24 kg) portable 1000 PSI Little Laser pressure washer and is scrubbed with bleach where needed. The holding area is cleaned two to three times a week or more often as needed. Unbacked Nomad vinyl matting is used as a substrate for the interior holding, and is removed with each cleaning and washed in 140-150°F (60-65.5°C) hot water and Bac-Stop solution.

The birds have free indoor/outdoor access but prefer staying inside during the night and most of the day during the fall and winter seasons. During breeding season from late winter through the spring the adult pairs continue to remain indoors occupying themselves with nesting, while the unpaired adults and juveniles begin spending increased amounts of time outside on exhibit. By summer the breeding pairs have joined the rest of the colony outside on exhibit prior to molting.

**HUSBANDRY**

For individual identification all the penguins are banded with clear plastic electrical cable ties marked with different colored tapes. The bands are fitted around the base of one flipper with enough allowance to accommodate the full width of the engorged wing during molt. All fledglings and new birds coming into quarantine are injected with a series of Aspergillosis fumigatus phenol inactivated vaccine. Fecal examinations are done annually and occasional trimmings are performed as needed for any overgrown beaks or toenails.

Three different types of fish are fed during the week; Three days of Eulachon also known as Columbia River Smelt (*Thaleichthys pacificus*), three days of Pacific Herring (*Clupea harengus pallasi*), and one day of live Rainbow Trout (*Salmo gairdneri*) provided by a trout farm which delivers 80, 4-8 inch (10.2 - 20.3 cm) small trout into the exhibit pool. Feedings are at 8am and 3pm, and each individual is hand fed until satiated. The remainder of the 10-12 lbs. (4.5-5.4 g) of fish fed each feeding is tossed into the outdoor pool for later foraging. Each bird gets approximately 1.5-2.0 lbs. (0.68-0.91 kg) per day. The fish is kept frozen and is thawed just prior to each feeding. Vitamins are stuffed into the fish gills.

**Daily vitamins per bird, maintenance:**

| 1 Centrum multivitamin |
| 100 mg B-1 vitamin, am & pm |
| 10 grain salt tablet |
| 1 vitamin “E” capsule, 100 I.U. 5 X week |

**Vitamins per bird, breeding pairs rearing chicks:**

| 1/2 Centrum multivitamin, am & pm |
| 100 mg. B-1 vitamin, am & pm |

(1000 mg. B-1 vitamin, am & pm (noon supplement added halfway through rearing for increased fish consumption)

| 1 grain salt tablet, am, noon & pm |
| 1 No. 0 gelatin capsule stuffed with Osteoform Improved powder, am & pm (approx. 1/8 tsp.) |
| 1 vitamin “E” capsule, 100 I.U. 5 X week |

The increase in the quantity of salt helps reduce dehydration which had occurred with regurgitating adults (Gailey-Phipps, 1978) and their chicks.

**BREEDING AND NESTBOXES**

Early signs of courtship, nest site selection, and aggression between males are seen in late December. The frequency of these activities slowly increase and culminate in breeding activity by February or early March. The males select the site and begin carrying sticks, litter and rocks to the nest site. Small amounts of dried Sword Fern fronds (*Polystichum munitum*) or dried London Planetree leaves (*Platanus x acerifolia*) are thrown into the holding area in each run for the males to find and carry back to the nest area. All collected leaf material in the nest is removed with each nestbox cleaning to prevent mold build up. Once eggs are laid leaf materials are no longer provided. These leaf-collecting forays induce competition between the males for possession of the leaf litter and this excitement is passed onto their mates. The access to leaf materials as a stimulus has increased the intensity of pair courtship, copulation, and nesting activities.

In the past, nest boxes were placed into the holding area before intense breeding behaviors were observed, but this did not hasten breeding. Due to the time and difficulty involved in cleaning nestboxes, they are now placed into holding when frequent Loud Mutual displays (Sparks and Soper, 1967) and precopulatory Arms Act (Warham, 1975) are displayed by the pairs. The pairs then immediately move into the boxes, and copulations occur shortly after. About 5-7 days later, the first egg is laid and incubation begins. The second egg appears 2-3 days later.

The nest boxes are made of 3/8 inch plywood and are totally collapsible for ease of access into the box. The boxes are approximately 21 inches (52.5 cm) wide by 21-30 inches (52.5-75 cm) high by 30 inches (75 cm) long are set up against the concrete wall of the runs. A detachable divider runs down the center of each run to prevent territorial fighting between the breeding males. The front half of the box top lifts off for viewing or access, and the front is also removable for nestbox cleaning and bird access. The boxes are actually facades consisting of only a top, front, and center divider set up against the back of each concrete run. Nervous females who prefer a more enclosed nestbox are given a removable lift-off foyer attached to the box entrance front.

The substrate upon which eggs are laid is a one inch (2.5cm) layer of pea gravel over a Nomad mat lining which can easily be lifted out for cleaning. Cleaning is accomplished by opening up
the box and moving the pair onto the ramp which leads to the exhibit pool and herding them into the water on display. The box is then opened up, eggs or chicks removed, mat lifted out, walls wiped down with Virosan solution, and the interior hosed out. The entire interior is then sprayed down lightly with the Virosan solution and a fresh mat and gravel is placed back in with the eggs/chicks. The box is put back together and the keeper waits a few feet away until the pair returns to the nest to ensure that the eggs and chicks are not left unattended. The process takes 10-30 minutes per box and is done every other day depending on each pairs' nestkeeping habits. This routine does not overly interfere with the breeding pairs' parenting routine. During incubation and rearing, the pairs become exceptionally broody and frequently check the holding area during cleaning in their haste to return to the nest.

When the eggs begin to pip, some water is poured over the gravel to increase humidity for the approximate 48 hours it takes the chicks to hatch. Once the chicks have hatched, the gravel is removed and just the Nomad mat is left as the substrate. This prevents the chicks from ingesting any gravel, which may result in impactions and death. This also facilitates cleaning. The box can be quickly wiped or hosed and the mat replaced with a clean one. All the soiled matting can be taken up and disinfected at a later time.

The chicks are weighed at least twice a day, three times if they are showing signs of stress or lack of sufficient weight gain. Signs may appear as lethargy, weight loss, dehydration, or a constant weight with no appreciable weight increase. Weighing is done in the morning after the pairs are fed, and again in the afternoon after the colony's last feeding. This ensures that the feeding is not disturbed when the boxes are opened and the chicks are pulled for weighing.

All attempts are made to allow the pair to rear their own chicks. When a chick shows signs of dehydration or lack of sufficient food intake based on weight gains, it is supplemented with formula via syringe and catheter tube during the weighings and is then placed back under the pair. This is done if the chick is not gaining or is losing weight. Typical 24-hour weight gains for healthy chicks range from 10-30 grams for the first week or two, to 100-300 grams for older chicks. Weight tends to stabilize as chicks near fledging. If supplemental feeding is begun, it continues until the chick shows good weight gains. This routine has worked well over the last few years, so that the less adept pairs have been successful in rearing chicks in spite of their lack of care, and they have improved in their rearing techniques with each successive clutch (Simpson, 1976).

When the chicks are pulled for longer periods of time, the pair is given a rock or dummy egg to brood until the chick's return. We do this every year with one pair that has had different mishaps during the night of their first two weeks of rearing. These mishaps have usually resulted in chick mortality. This pair's chicks are automatically pulled and moved into a brooder for the night around 6 pm and are returned to the nest the next morning at 7 am for the first two weeks. When the chicks are 2-3 weeks old, they have begun thermoregulating and are more mobile with their increased body size, they are less susceptible to injury. The pair is then able to finish rearing the chicks to fledging with occasional supplementation during chick molting.

At two weeks into chick rearing, a third feeding is added for the adults that are regurgitating. As the chicks' size and food intake increase, the adults begin to consume larger amounts at each feeding. With the larger amounts of fish eaten, signs of dehydration frequently appear in both chicks and adults. This may partially be due to the small area of the indoor holding space used for nesting, and the pairs' unwillingness to leave their nest sites and go into the water on exhibit during breeding. Dehydration signs in both adults and chicks appear as lethargy, loss of appetite and excessive skin "tenting". Chicks also show dehydration in their weight, and adults by a gradual or sudden cessation of regurgitation. The pairs are supplemented by soaking all prepared fish in water, increasing salt tablet supplements, and if needed injecting fish with Pedialyte. The chicks are most likely to begin showing signs of dehydration and stress around 12-14 and 45-50 days of age. Around 12-14 days they begin to thermoregulate, walk and move about, and their second coat of down begins to emerge. Around 45-50 days they begin molting again into feathers. These physical developments place a short intense strain on their body systems and they are more likely at this time to have dehydration problems. Increased amounts of Pedialyte are added to the formula supplements to help reduce dehydration. Supplementation and weighing continue through fledging, at which time the chicks' condition is visually monitored, and weighing is discontinued. The pairs continue regurgitating for some period of time while the fledglings learn foraging and eating techniques from the adults.

The individual hand feedings, nestbox intrusions for feeding and cleaning, and the chick weighings are all well tolerated by the breeding pairs when done by staff they are totally familiar with. Sudden changes in keeper staff during breeding have caused pairs to leave their nestboxes for extended periods, to refuse to eat (therefore having no food to regurgitate), and have caused intense agitation in pairs trying to guard nestboxes and chicks.

**PENGUIN CHICK FORMULA - DAYS 1-7**

<table>
<thead>
<tr>
<th>Amount</th>
<th>Ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cup</td>
<td>Herring, cut into chunks, remove heads, tails, and fins.</td>
</tr>
<tr>
<td>1/4 cup</td>
<td>Isocal</td>
</tr>
<tr>
<td>1/4 cup</td>
<td>Pedialyte</td>
</tr>
<tr>
<td>1 cc</td>
<td>Amino-Plex</td>
</tr>
<tr>
<td>1 cc</td>
<td>Stat-VME</td>
</tr>
<tr>
<td>1/4 tsp</td>
<td>Osteoform</td>
</tr>
<tr>
<td>1</td>
<td>Vitamin E capsule, 100 IU</td>
</tr>
<tr>
<td>1</td>
<td>Vitamin B-1 tablet, 100 mg</td>
</tr>
</tbody>
</table>

**PENGUIN CHICK FORMULA - MAINTENANCE**

<table>
<thead>
<tr>
<th>Amount</th>
<th>Ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cups</td>
<td>FISH: half herring, half smelt. Prepare and measure as described below.</td>
</tr>
<tr>
<td>4 cups</td>
<td>Pedialyte</td>
</tr>
<tr>
<td>8 cups</td>
<td>Amino-Plex</td>
</tr>
<tr>
<td>1 cup</td>
<td>Stat-VME</td>
</tr>
<tr>
<td>2 cc</td>
<td>Centrum multi-vitamin tablet</td>
</tr>
<tr>
<td>4 cc</td>
<td>Vitamin B-1, 100 mg tablet</td>
</tr>
<tr>
<td>8 cc</td>
<td>Vitamin E, 400 IU capsule</td>
</tr>
<tr>
<td>1</td>
<td>Osteo-Form Improved Powder</td>
</tr>
<tr>
<td>1/2 tsp</td>
<td>1/2 Tbs 1 Tbs</td>
</tr>
</tbody>
</table>
Table 1. Hand-feeding of chicks. See page 13 for abbreviations and notes.

<table>
<thead>
<tr>
<th>CHICK WT</th>
<th>FEEDINGS PER DAY</th>
<th>FISH</th>
<th>FORMULA</th>
<th>PEDIALYTE</th>
<th>PREPARATION &amp; SUPPLEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 100 g</td>
<td>6</td>
<td>1-3</td>
<td>1-2 cc</td>
<td></td>
<td>12 fr. latex catheter, 6 cc syringe with catheter tip adapter. Formula tubed into stomach.</td>
</tr>
<tr>
<td>DAY 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 100 g</td>
<td>6</td>
<td>1-3</td>
<td>3-8 cc</td>
<td></td>
<td>12 fr. latex catheter, 35 cc catheter tip syringe. Tubed into stomach.</td>
</tr>
<tr>
<td>DAY 2-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 200 g</td>
<td>6</td>
<td>1-3</td>
<td>5-15 cc</td>
<td></td>
<td>18 fr. latex catheter, 35 cc catheter tip syringe. Tubed into stomach.</td>
</tr>
<tr>
<td>.DAY 3 - 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200 - 300 g</td>
<td>6</td>
<td>1-3</td>
<td>15-25 cc</td>
<td></td>
<td>22 fr. latex catheter cut into 3 inch piece, pushed onto end of 35 cc syringe. Tubed to back of throat.</td>
</tr>
<tr>
<td>.DAY 7 - 13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 - 500 g</td>
<td>6</td>
<td>1-3</td>
<td>30-50 cc</td>
<td></td>
<td>as above, 60 cc catheter tip syringe. Tubed to back of throat.</td>
</tr>
<tr>
<td>.DAY 10 - 18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 - 600 g</td>
<td>6</td>
<td>1-3</td>
<td>55-65 cc</td>
<td></td>
<td>same as above</td>
</tr>
<tr>
<td>.DAY 14 - 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 - 900 g</td>
<td>5</td>
<td>1-3</td>
<td>60-100 cc</td>
<td></td>
<td>same as above</td>
</tr>
<tr>
<td>.DAY 19 - 32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>900 - 1700 g</td>
<td>5</td>
<td>1-3</td>
<td>120 cc</td>
<td></td>
<td>same as above</td>
</tr>
<tr>
<td>.DAY 25 - 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700 - 1900 g</td>
<td>5</td>
<td>1-3</td>
<td>140-150 cc</td>
<td></td>
<td>same as above</td>
</tr>
<tr>
<td>.DAY 38 - 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900 - 2600 g</td>
<td>5</td>
<td>1-2</td>
<td>160 cc</td>
<td></td>
<td>same as above</td>
</tr>
<tr>
<td>.DAY 41 - 56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2600 - 2700 g</td>
<td>5</td>
<td>1-2</td>
<td>3-5 whole small* herring; 8 am, noon, 4 pm</td>
<td>150 cc</td>
<td>10-60 cc ** *Slowly increase fish, starting with 1 every other feeding. **Pedialyte as needed for dehydration. Dilute formula with equal portion Pedialyte, mix with formula for syringe administration, or stomach tube fluids at fish feedings. Begin Vitamin suppl. &quot;A&quot;.</td>
</tr>
<tr>
<td>.DAY 50 - 57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2700 - 3000 g+</td>
<td>3</td>
<td>1</td>
<td>10-15 herring</td>
<td>150 cc</td>
<td>10-60 cc am &amp; pm *** As above ***if needed</td>
</tr>
<tr>
<td>.DAY 51 - 72</td>
<td></td>
<td></td>
<td>8 am &amp; 4 pm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fledge</td>
<td>2</td>
<td>--</td>
<td>5-15 whole smelt</td>
<td>--</td>
<td>30-60 cc § §Continue fluid supplement as needed if chicks have no access to water source. Osteo-Form capsule supplement continues to DAY 100, when adult vitamin suppl. begins.</td>
</tr>
<tr>
<td>.DAY 56 - 78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Penguin Husbandry at Woodland Park Zoo... cont'd from page 11

PREPARATION OF CHICK FORMULA

Pulverize tablets with mortar and pestle before adding to the blender: break vitamin E into blender and discard empty capsules. Fish is cut into 1 inch chunks to facilitate blending. Heads, tails, and fins are removed until chick reaches a weight of 900-1700 g. When measuring fish, pack firmly into cup; one cup equals about 100 g. Store formula no longer than 24 hours. Heat quickly, only enough to remove chill. Never store and re-use heated formula.

When the chicks weigh 2700-3000 g, if dehydration becomes a problem the formula can be watered down by using the largest formula above, with only 4 or 5 cups of fish.

NOTES FOR CHART ON PAGE 12

1) Hand-reared ("HR") chicks are receiving all food from keeper; parent-reared chicks ("PR") are being removed from nest for feeding, as shown, to supplement their parents' feedings.
2) Overlaps in age and weight categories reflect variations in growth rates of individual chicks.
3) Vitamin Supplement "A" (day 50 on chart at left) consists of:
   - 100 mg Vitamin B-1 twice a day
   - 10 grains Salt Tablet twice a day
   - 1/2 Multivitamin Tablet twice a day
   - 1 Osteo-Form Capsule once or twice a day
4) Until chick reaches 900-1700 g stage, prepare fish by removing heads, tails, and fins; thereafter, whole fish may be used, in either case, fish may be cut into 1 inch chunks for easier blending.
5) Full length catheter tubes are used for supplemental feedings of parent-reared chicks.
6) All feeding equipment must be sterilized after each use and between feeding different chicks.
7) All weights and formula amounts are only general guidelines, based on high and low data recorded from both hand-reared and parent-reared chicks.
8) If bloating occurs, gas may be drawn out by inserting a catheter tube. Formula amounts should be reduced. If bloating is severe, skip next formula feeding and supplement with 10-60 cc Pedialyte (tubed) to help flush out system.
9) Near fledging, whole fish are introduced. Our experience has been that feeding small fillets and fish earlier in the rearing caused repeated episodes of bloating and digestive problems.

PRODUCTS MENTIONED IN TEXT

Aspergillus fumigatus (vaccine): manufactured by Willamette Laboratories, 9180 N.E. Sandy Blvd., Portland, OR 97220
Bac-Stop (Didecyl dimethyl ammonium chloride): manufactured by Seaport Chemicals, 1215 E. Columbia, Seattle, WA 98122
Little Laser (portable high pressure washer): manufactured by Clarke, 2800 Estes Street, Muskegon, MI 49441
Virosan Solution (Chlorhexidine diacetate disinfectant): manufactured by Bio-Ceutic Division, Boehringer Ingelheim Animal Health, Inc., St. Joseph MO 64502
Nomad (brand of vinyl matting): manufactured by 3M Building Service and Cleaning Products Division, Building 223-65-03, 3M Center, St. Paul MN 55144-1000
Pedialyte (brand of oral electrolyte maintenance solution): manufactured by Ross Laboratories, Columbus, OH 43216
Stat-VME (high calorie liquid diet): manufactured by PRN Pharmacal, Inc., Pensacola, FL 32504

REFERENCES


E.L. Harris
Woodland Park Zoo
Seattle, Washington USA
Behavioural and Morphological Sexing
of the Humboldt Penguin (*Spheniscus humboldti*)

by D. G. Edginton

One of the many problems facing bird keepers is the accurate sexing of bird species in which both sexes have the same pattern and coloring (monomorphism). This is a particular problem with species that have subspecies showing slight variations in pattern and colour as these can often be misinterpreted as sexual differences. With some monomorphic species, sex can be determined relatively easily; manipulation can be used with some species of waterfowl, eye colour variations with certain species of hornbill and cockatoo, and size and weight differences with many birds of prey.

The Humboldt penguin poses a particular problem as both sexes are virtually identical externally and any slight variations are almost unnoticeable until other factors are taken into account. Fortunately, confusion caused by subspecies does not occur, as none are recorded. There are a few methods of determining sex with the Humboldt penguin but most have proven to be impractical, unreliable, or financially prohibitive (chromosome analysis, hormone analysis, laparoscopy). Cloacal sexing appears to be reliable with adult birds but even this method is not commonly used in zoological collections in Britain and few keeping staff have the knowledge or access to the specialised equipment needed to perform this procedure, so often behavioural indications over a prolonged period must be the determining factor. Unfortunately, these will not always give the correct information as the most obvious sexual differences will not occur until the individual has found a partner and is sexually mature. This will be a minimum of two years and even then a friendship bond may occur between two birds of the same sex.

Having proven pairs will give an indication of the group sex ratio but will not identify the sex of each individual in the pair and this still leaves the problem of sexing unpaired adults, unproven bonded pairs, and juveniles. It is important to be able to identify the sex of these particular group members for positive pairing of adults and unrelated juveniles, to avoid friendship bonds and to eliminate inbreeding. Positive sexing will enable keeping staff to encourage suitable pairings which, in turn, will maximise the group breeding potential.

Of the seven species of penguins exhibited in this country, the Humboldt is by far the most numerous, with close to 300 individuals distributed amongst 28 collections. The aim of the paper is to assist and encourage keeping staff in sexing Humboldt penguins by simple observations that can be made during their day-to-day contact with the group and by a few routine measurements taken throughout the year. Hopefully this will help to produce more positive pairings of unrelated birds and help safeguard the future of our captive Humboldt population. This is of particular importance at a time when this species is becoming more endangered in its natural environment.

**Morphological Indications**

Many of the measurements under this heading are more reliable when used to determine the individual sexes of proven pairs.

Example: The weights of two separate pairs could be -

- **Pair A.** 3.5 kg Male and 3.0 kg Female
- **Pair B.** 4.0 kg Male and 3.6 kg Female

These weights taken individually would indicate the two heavier birds to be male and the lighter two, female. Only when taken as comparisons between proven pairs do they indicate the actual sex of each bird. Greater care and reference to all the indications listed should be taken when attempting to sex any Humboldt penguin, particularly when sexing unpaired and juvenile birds.

(The sections marked * indicate that they are most reliable when used on a proven pair, to determine which is the Male and which the Female; when used on unpaired birds, these indicators should be taken in combination with several other indicators for better results.)

*SPN* May, 1989 page 14
1. WEIGHT

A. Normal weight

Normal weight should be measured during the period between one month post/one month pre moulting, so as not to obtain a false reading when the bird is recovering weight after molt or building weight before molt.

B. Maximum Weight (Molting Weight)

Should be measured as soon as feather loss begins.

2. HEAD SHAPE

A. High Forehead

Broader bill

B. Low Forehead

Slimmer bill

Top of head less rounded than A.

C. Profile between A and B, with broad head.

Indicates Male

D. Profile A, with shaped head like B.

Indicates Female

These are the more common head shapes. Other variations of these characteristics are more difficult to give an indication from.

3. HEAD AND BILL

When measuring the bill, any abnormal or overgrowth should be taken into account, particularly when measuring width.

A. Length of Bill

With paired birds, the length is generally the same, but, if a difference occurs the Male’s bill will be longer.

B. Width of Bill (at base)

As above - if any difference occurs, the Male’s bill will be wider.
3. HEAD AND BILL (continued)

C. Breadth of Bill (at base)

- Male's is generally wider

D. Total length of Head and Bill

- Male's is longer

4. BODY

A. Overall Height (Top of head to tip of tail)

*With paired birds where a difference occurred, the Male was taller

B. Body Shape (when viewed from the rear, with the bird in a normal standing rest position):

More muscular appearance, particularly top of legs
Indicates male

Smallerer lines, less muscular in appearance
Indicates Female

C. Wing length

- Male's wings are generally slightly longer

5. MOULT

A. First feather loss and onset of fasting

*Generally Male

6. SKIN

A. Skin patches above and below base of bill swollen and flushed dark pink (especially around breeding season)

Indicates Male

B. Slightly swollen and dark pink.

Indicates Male

C. Slightly swollen with pale flush.

Indicates Female

D. No swelling, with normal color or pale pink flush.

Indicates Female

7. DOMINANCE

A. Over partner

The male is the dominant partner, taking the initiative in mate selection, choice of nest site, nest building, etc. He will also dictate much of the daily movement of the pair around the penguin enclosure. This dominance shows itself most commonly through appeasement behaviour from the Female (this most often occurs when a pair are disturbed by a staff member whilst they are inside their nest box). The Male will confront the Female who will immediately turn her head away, lowering her bill and moving it from side to side as a gesture of submission. (This action is probably his way of reinforcing his claim over the Female with the keeper being looked on as competition.) He will sometimes induce a similar response from the Female at feeding time by persistently
7. DOMINANCE

A. OVER PARTNER (continued)

pushing her head away from the food container until he has finished feeding (he will simply compete with any other birds around the same food container)

B. Over other Penguins in the Group

There appears to be no dominance hierarchy among the adult birds of this species, or over other penguin species kept in the same enclosure (observations made with King, Magellan, and Rockhopper penguins). Both sexes (particularly Female) will however assert their position over juveniles introduced into the group, attempting to solicit a submissive response by use of aggression.

8. AGGRESSION

A. Towards Partner

Direct aggression is almost always caused by interference from the other adult pairs (usually by a neighbouring pair accidentally entering the wrong nest box). During the scuffle, the Male will sometimes turn on his partner accidentally or in excitement; the Female will then retaliate. Any direct aggression outside this is rare.

Fairly common - can be caused by competition for nesting material, territory protection, or any unusual occurrence in and around the penguin area - usually instigated by the male.

B. Towards other Penguins in the Group

The male will generally guard his territory around the nest box during the breeding season. If an intruder enters this area he will use threat rather than direct attack (the threat posture involves the Male stretching his body to its fullest height, slightly lifting his wings and inclining his bill toward the intruder. He will then walk slowly forward and, without any contact, walk the intruder from the area.) He will only use direct attack if the intruder enters the nest box; in this event, the Female will also assist in the attack.

If another penguin enters the nest box both partners will attack. During these fights, protection of the nest box appears to take precedence over protection of any eggs or chicks present and these will often be trampled. After any disturbance of this kind it is usually the female who will resume incubation even if the Male was incubating at the onset of the aggression. (Attack is performed by the aggressor stabbing or gripping the head or bill of the victim whilst, at the same time, striking with one wing.) Both Male and Female will show immediate aggression when disturbed by a keeper checking for eggs or chicks, the Male being more persistent in his attack; the Female will offer only a token attack and sometimes leave the nest box in panic.

please turn to page 18
9. VOCALISATION

A. Outside the Breeding Season

Vocalisations are frequent and mainly take the form of mutual calls such as location and greeting calls. Group or mutual braying will also take place at feed times or when a member of the staff enters the enclosure. It is also quite common for group braying to be induced by any non-routine occurrence in or near to the enclosure. The location call between a pair (a short single bray) will most often come from the Male first with the Female replying immediately, but this call will often cause other pairs to call to each other making identification of the first call from each pair (given by the Male) difficult.

Occasionally ecstatic display calls will take place. (Ecstatic Display - see 10 F) The ecstatic display will most often be performed by the Male and will sometimes excite other group members to begin the same display.

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B. During the Breeding Season

Other types of vocalisation directly associated with behavioural indications (i.e. neck rubbing, ecstatic display, etc.) will be covered under their behavioural headings.

10. DISPLAY AND BOND REINFORCEMENT

A. Neck Rubbing

This often follows ecstatic display but can occur at any time during breeding season prior to egg laying. The Male will approach the Female and she will bow her head, moving her bill from side to side. The Male will then place his neck over the back of hers and rub from side to side. Both will give a quiet chuckling bray and, often, back climbing and wing hitting will occur at the same time. This display will sometimes precede copulation, but most of the time appears to be more of a bond reinforcement as the Male makes little or no attempt to force the Female down as is common in some penguin species.

B. Wing Hitting

Usually occurs after mutual calling during the breeding season, almost always performed by the Male. Will occasionally precede copulation or back climbing. (During wing hitting, the Male will stand behind the Female and strike her sides with both wings in a flapping movement.)

C. Back Climbing

The Male will stand directly behind the Female and use his feet in a scratching movement on her lower back (often performed together with neck rubbing, sometimes stimulating the Female to copulation; the Male also back climbs during copulation on most occasions). Always performed by the Male.
10. DISPLAY AND BOND REINFORCEMENT  
(continued)

D. Mutual Preening  
Usually instigated by Male.

E. Allo-preening  
Less common, more likely to be instigated by Female with Male reciprocating immediately.

F. Ecstatic Display  
Performed by the bird stretching its body to its fullest extent, stretching its wings out behind the body and sky pointing with the bill. It will then lean forward and give a series of continuous loud brays. (For indication, see Section 9 A and B)

G. Reinforcement Gesture  
The Female will approach the Male and point her head towards his feet, moving her head from side to side. She will give a quiet braying sound, similar to the call used in neck rubbing. He will occasionally return the gesture.

11. NESTING

A. Choice of Nest Site  
Male

B. Nest Building  
Almost always instigated by the Male carrying material to the chosen nest box. This will often spread over several days before the Female joins in. Soon after this, she will begin to spend more time in the box, receiving and arranging material collected by the Male. When the nest is almost complete, she will spend most of the day in the box re-arranging the nest and will sometimes miss feeds. The Male will spend his time near the box, rarely venturing far. (This may be due to the relatively large number of penguins in our group and the close proximity of other nesting pairs. The Males may not be as protective in a smaller group where the nest boxes are further apart.)

C. Stealing Nest Material  
The Male will often steal nest material from other boxes whilst their owners are absent. This usually occurs after his own nest is completed and appears to be a bond reinforcement with the Male presenting a gift to the Female at the nest.

12. MATING

A. Copulation  
The most obvious indicator of the individual sexes of a pair (but see paragraph one of the text following this chart).

B. Tread marks  
On the lower back of the Female, caused by the movement of the feet of the Male during copulation.
13. INCUBATION

A. Sitting

The pair will share this duty but the Female will sit slightly more than her partner. The Female will sit for longer during the daylight hours. (Returning to eggs after disturbance - see Note 8 D)

B. Attendance

When the Female is incubating, the Male will sometimes stay beside her but will more often stand guard at the box entrance; when the Male is incubating, the Female will also spend some time in attendance but will leave the box more often and will rarely stay in the nesting area.

C. Stone Sitting

Occasionally a bird will select a stone or pebble and attempt to incubate it. This generally occurs during the early part of the breeding season and the bird may stone sit for up to two weeks. (If the stone is taken away, another will often be selected and the sitting will continue.) Stone sitting in our group is occasionally performed by a Male whose partner does not lay her eggs until late in the season.

In some bird species, two birds of the same sex may form a mock bond. I have observed this first hand in several parrot species. Two females will act as a pair going through all the motions of nesting, food passing and even copulation. Often only one of the birds will lay her eggs in the nest, the other assuming the role of the male. Both adult and juvenile penguins, in the absence of suitable partners, will form single sex friendship bonds. Sometimes box sharing, wing hitting and even neck rubbing will take place. I would be very interested to hear of any record of this activity going further.

I would like to point out that I am only giving indications and that there are no golden rules for positive sexing. But, with a few careful observations and the use of this paper, you should be able to average out the behavioural and morphological differences listed to give a very good indication of the sex of each individual group member. (When attempting to sex juveniles, the indications are more noticeable after the bird has reached 4 months.)

All of the indications listed are from observations made whilst working with Humboldt penguins firstly at Birdland (Bourton-on-the-water, Gloucestershire) and currently at The Cotswold Wild Life Park (Burford, Oxfordshire) and from visits to several zoological collections during recent years. I have tried to avoid using references and secondhand information. Whilst I have tried to make this paper as thorough as possible, I have only included behavioural characteristics relevant to sex indication and any characteristics applying equally to both male and female have been omitted. I would be grateful for any further information or criticism and to hear of any contradictory behaviour in other Humboldt penguins. Any valid information received will be added to the indications list.

Our penguin group at The Cotswold Wild Life Park has been very successful and is totally self-sustaining with no new birds having been introduced since The Park opened nineteen years ago. By using the method of sexing mentioned, we have been able in recent years to positively sex and pair all of our Humboldts and have now bred the third generation (this generation having produced fertile eggs) with no inbreeding.

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SPN May, 1989 page 20
Sexing Penguins by Cloacal Examination

This photo, taken in the course of field work on sexing methods, shows the cloacal areas of a pair of Magellanic penguins. Their tails are toward the top of the frame, legs at the bottom being held by gloved hands. The original, in color, is much more distinct, but even this version shows a clear difference between cloaca sizes of female (left) and male.

The term "cloacal sexing" is sometimes used to describe a more invasive procedure in which the cloaca is mechanically dilated to permit internal examination. In the work described below, however, sexing was carried out with very high rates of accuracy by measuring the external cloaca. This procedure might be helpful to some institutions, which know that they have bonded pairs, but are not sure which of the pair is the male and which is the female. The accuracy rates for sexing Magellamics by this method were (when using both length and width measurements for each bird) 87% for females, and 100% for males.

The process is summarized in the following excerpt from the research article in Auk, but for complete details and statistics the original article should be consulted.

"Early in the season female vents dilate to allow the passage of the disproportionately large egg...the limitations on the technique [are that] only females that had recently laid eggs, and their known mates, could be sexed by examining their vents...two measurements of the vent were made with needle-nosed calipers: the transverse, or lateral, length; and the cranio-caudal width....We swabbed the birds' vents with 10% alcohol, which wet the surrounding feathers so the raised fleshy lips of the vents could be seen clearly and measured. The stimulation and cooling effect of the alcohol uniformly caused the birds to contract their sphincters. Females that had recently laid eggs could not contract their vents as small as males, so by stimulating contraction maximum differences in vent size between the sexes was measured....we measured the vents of 62 breeding Magellanic Penguins within 2 weeks of egg-laying, and again a month later. [To confirm the results of this sexing procedure] We independently sexed these birds by bill length and depth, a technique that is 94% reliable (Scolaro et al. 1983)..."


SPN May, 1989 page 21
One question in the recent survey asked what subjects the respondents would most like to see addressed in future issues. The topics range from the general (“Handrearing”) to the very specific (“Effects of water and air temperatures on activity levels”). The responses are summarized below, and we ask that readers with something to contribute on any of these topics will communicate with us. If you are willing to write an article on one of these subjects, drop us a note and let us know; if you would just like to send a short communication summarizing your institution’s experience, offering a suggestion, or asking a question, that is fine too. Among our readers, at about 125 institutions, there is an immense amount of information and expertise; please share yours with others, so that we can all benefit.

Topics most often mentioned are marked (*).

**Handrearing**

- Nestbox design
- Activity levels, and how to increase them in an indoor exhibit
- Effects of water and air temperature on activity levels
- Factors effecting future breeding of handreared birds
- Alternatives to completely pulling chicks in order to teach them to eat from keepers
- Problems with delayed molt; ways to encourage molt*
- Pool sanitation; what practices and chemicals are safe
- Cleaning agents for concrete floors
- Training penguins
- Natural history in the wild*
- Sexing chicks, juveniles, and adults*
- Behavioral enrichment
- Exhibit design: pool size and shape
- Staffing requirements for good management
- Keeper staff stability, and how to increase it
- Causes of poor feather condition
- Aspergillosis, prevention and treatment
- Nutrition: diets, supplements*
- Photoperiods
- Common diseases and current treatments*
- Preventive medicine
- Bumblefoot
- Malformation of beaks
- Chick mortality*
- Field ecology
- Artificial incubation
- Exhibit problems: waterproof paint, anti-fogging techniques for windows
- Banding and identification of individuals*
- Care of parents during breeding and chick-rearing
- Group dynamics
- Abnormal stripe patterns, “extra” stripes

**Recent Publications**