process was necessary and the family was re-united without complications.

CONCLUSION
Although we have found no previous references to this specific problem in the literature, from our experience, it would appear that the initiation of weaning is a crucial point in the development of young Oriental small-clawed otters. It appears to be critical that the young are eating solid food by at least 97 days of age in order to maintain good nutritional status. Research is needed to determine the various stimuli which evoke the eating of solids by individuals within a litter. Such information could be used to facilitate the weaning process of captive-bred Oriental small-clawed otters.

ACKNOWLEDGEMENTS
I would like to acknowledge the co-operation and advice of the following: E. Bronikowski, L. Bush, Dr M. Bush, Dr K. Carlstead, D. Margetis, T. Miller, L. Moore, V. Rico, R. Strauss and W. Xanten.

PRODUCTS MENTIONED IN THE TEXT
Clinical Care Feline Liquid Diet: manufactured by Pet-Ag, Inc., Hampshire, IL 60140, USA.

Esbilac Milk Replacer for Puppies: manufactured by Pet-Ag, Inc., Hampshire, IL 60140, USA.
Gerber Rice Cereal: manufactured by Gerber Products Co., Fremont, MI 49412, USA.
Kaopectate: antidiarrhoeal, manufactured by The Upjohn Co., Kalamazoo, MI 48901, USA.
Pedialyte: electrolyte manufactured by Ross Laboratories, Columbus, OH 43216, USA.
Zu/Preme Feline Diet: manufactured by Hill’s Pet Products, Topeka, KS 66601, USA.

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Manuscript submitted 28 August 1991


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Hand-rearing three species of gazelle
Gazella spp
in the Kingdom of Saudi Arabia

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King Khalid Wildlife Research Centre, Saudi Arabia, has one of the largest collections of gazelles in the world. It is managed by The Zoological Society of London for the National Commission for Wildlife Conservation and Development as part of the Kingdom’s conservation programme.

The bulk of the 750 animals held on the site represent three species, the Arabian sand gazelle or Rheem Gazella subgutturosa marica, the Mountain gazelle or
Idmi Gazella g. gazella and the Sudanese dorcas Gazella dorcas dorcas. To aid various aspects of management of the gazelles and to provide animals for research projects, a major programme of hand-rearing was set up over a two-year period. A total of 69 neonates was taken for rearing. During the first season the mortality rate was over 50% but in the second year 95% of the infants were successfully reared to independence and returned to the main herds. The main problems encountered in the first year were urine retention, mutual genital suckling and poor feeding techniques. Many, but not all, of the difficulties were related to an inexperienced staff attempting to handle too many animals. During the second year most of the problems were solved and a workable routine for hand-rearing was established.

COLLECTION
The main gazelle herds at the Centre are kept in an enclosed area of c. 400 ha. All the young for hand-rearing were taken from this enclosure, the majority during the main birth season of March and April. The large area made the initial location of suitable neonates difficult particularly as only those which were seen during the birth or which were still wet were collected.

Since the first hours are critical in establishing a good foundation for hand-rearing, a maximum of four neonates was brought into the nursery on any one day to allow staff to spend more time with each individual. The newborn infant was given a full veterinary examination and cleaned, if necessary, before being moved into the nursery. The weight and body measurements were taken at this stage and the infants ear tagged for identification. The mean weight of 21 neonate *G. subgutturosa marica* was 1.88 kg and that of 16 *G. g. gazella* was 2.08 kg.

ACCOMMODATION
The nursery area was one large room containing a number of holding units, measuring 80 × 80 × 80 cm high. The pens were made from light plywood with a removable panel at the front to allow the infants the freedom of the remainder of the room at feeding times. Coarse sand, carefully selected to avoid fine dusty material, was used as a substrate in the pens. Originally the temperature of the rearing room was maintained at 15–20°C. More recently, however, it was found that the young were able to cope without heating, even though the ambient temperature can drop to 10°C at that season of the year.

For the first two weeks the neonates were allowed contact with each other during feeding but housed individually because very young animals kept together for long periods may develop the habit of genital suckling. Between two and three weeks of age the animals were moved to 3 × 3 m pens where up to four could be kept together. The pens had access to an outside run of 15 × 5 m with a grass and concrete substrate, allowing the animals ample room to exercise which they appeared to enjoy. A 1 m high fence of chicken mesh around the enclosure was sufficient to contain the young until they were moved to permanent quarters at three months of age.

FEEDING
During the first season, one of the major difficulties was encouraging the neonates to accept bottle feeding. Some individuals did not develop a good suckling technique causing them frequently to spit out the teat or the take the feed very slowly. We found that bottle feeding behaviour depended greatly on the time spent with an animal in the first few days. It is important to encourage an infant to feed without forcing it and time devoted to the task at the initial stage is saved by ease of feeding later. A number of techniques, many of which have been clearly described by Oosterhuis (1986), were adopted to encourage a feeding rapport. Some infants, however, responded well and took even their first bottle quickly.
The period of time before the first feed was accepted varied considerably, some animals not feeding for up to 53 hours. This observation may, however, be misleading as suckling is an integral part of the post-partum cleaning process and, even though they were still wet when collected, some of the neonates may have already taken their first feed.

The number of staff caring for the infants was limited for the first few days but once feeding routines were established other staff became involved to reduce the danger of the young becoming imprinted on one person. The familiarity with different keepers also helped during the transition periods when the gazelles were moved to new areas.

Until the infant was feeding well, soft rubber lamb teats on plastic bottles were used but as soon as possible these were replaced by teats used for human babies on holders with disposable plastic bag inserts to reduce the cleaning time. The holes in the teats must not be too large since it is very important that the neonate actively suckles to obtain milk because this stimulates the oesophageal reflex. All equipment was soaked in Milton sterilizing fluid between feeds.

When available, bovine colostrum was fed for the first 48 hours. However, infants which did not receive this have shown no ill effects. On the other hand, no adverse reaction, such has been shown with some species (Morgan, 1989), was observed in infants which did receive the colostrum. A mixture of UHT milk and unsweetened evaporated milk was used for all subsequent feeds in a 1:1 ratio. Initially five feeds a day were given at three-hour intervals between 0800 and 2000 hours. This had been reduced to two feeds by day 50. On the first day a maximum of 50 ml was given at each feed and gradually increased to a maximum of 150 ml as the infant developed. During the first season the volume of milk given to each animal at each feed was estimated at 10% of its body weight but the calculation became unnecessarily time consuming when preparing feed for a large number of infants and during the second year it was possible to work to a standardized regimen based on previous experience (Table 1).

Generally the gazelles took all the feed well and were prepared to take more than the amounts offered. The quantities were limited to prevent over ingestion and to encourage solid food intake. While the infant was feeding the perineal area was rubbed gently to stimulate elimination. By the third week most infants were urinating without stimulation. During the first season urine retention was a problem with Rheem 333 unless sufficient stimulation was given. When suffering from retention an infant's abdominal region could become bloated causing great discomfort and suppressing the individual's appetite. Genital suckling caused sore penises which also discouraged urination. This problem was prevented by staff allowing sufficient time at each feed to work on the infant until it urinated.

During feeding the infants raise and lower one hind leg in a stamping action similar to that described by Appleby Frank (1983) for Gazella leptoceros. In their enthusiasm some infants were messy feeders and required cleaning afterwards. From as early as week 1 dried alfalfa and concentrate were offered and within two weeks most young were eating some solids. From the age of four weeks fresh alfalfa could be given but it caused diarrhoea in the younger animals. Although

<table>
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<th>AGE (days)</th>
<th>NO. OF FEEDS/DAY</th>
<th>MAX. VOL/FEED (ml)</th>
<th>AVE TOTAL VOL/DAY (ml)</th>
</tr>
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<tbody>
<tr>
<td>0–21</td>
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<td>80</td>
<td>350</td>
</tr>
<tr>
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<td>4</td>
<td>110</td>
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<td>36–49</td>
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<td>150</td>
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<tr>
<td>50–70</td>
<td>2</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>70–weaning</td>
<td>1</td>
<td>100</td>
<td>100</td>
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</tbody>
</table>

Table 1. Summary of feeding regime for hand-reared gazelles Gazella subgutturosa marica, G. g. gazella and G. d. dorcas at King Khalid Wildlife Research Centre.
weaning should be completed by week 12, the young gazelles continued to be offered one bottle feed a day until they were established in their adult quarters. This handling helped to develop the relationship with new staff as the animals were moved from one area to another within the collection. Mother-reared gazelles will suckle at 12 weeks of age if the dam allows them but there have been cases of infants taken from their dams as early as three weeks old and surviving on solids only having refused to take milk from a bottle. Throughout the hand-rearing period a multivitamin preparation was added to the milk on a weekly basis. Mineral salt licks were made available from the third week and these were used by most animals.

The infants were weighed daily for the first few weeks and then at weekly intervals. We found that the best way to hold an infant during weighing was in a large cloth bag but some animals struggled against this and after two months only the co-operative animals were weighed regularly.

HEALTH
Infants which were bad feeders in the first season tended to have more problems than the good feeders. Time spent in the first few days with each animal encouraged a positive feeding response and seemed to produce a much easier animal with which to work.

Inter-suckling of the genitals was avoided by keeping the young separated during the first week. Although the habit could be related to feeding behaviour, it could be stress related and a more relaxed animal may not need the comfort of suckling.

When moved from the nursery one group of infants picked up coccidia but this was treated successfully with Sulfasol. At eight and ten weeks of age two G. g. gazella developed what appeared to be a central nervous system disorder which was diagnosed and treated as a vitamin B deficiency. The condition causes dehydration, weight loss, loss of co-ordination and 'star-gazing'. It was treated successfully by 3–5 ml of Parentrovite multidose injection given intramuscularly. The condition recurred in one individual two months later. It appeared that the animal was unable to utilize vitamin B properly and, although it survived to 18-months of age, another recurrence of the problem caused its death.

Two Rheem had corynebacterium infection in their mouths, which caused swollen gums and small abscesses but treatment with 1·5 ml Baytril 5% injectable solution given subcutaneously or 1 ml Depomycin 20/20 intramuscularly cleared the problem. It is probable that the infection started during tooth eruption and, although treatment was successful, the adult animals still show the results of the condition, having lost some teeth.

If, as occurred occasionally, an infant was unusually subdued without showing specific symptoms of illness, an iron supplement was added to the milk or 1 ml of Fercobsang 12 was injected intramuscularly. This seemed to help the condition but it was not necessary to give it regularly. Despite the low levels of iron found in domestic cow’s milk (Stathatos & Kirkwood, 1989), anaemia was not a common problem.

DISCUSSION
A comparison between weight increases in eight hand-reared and three mother-reared Rheem is shown as Fig. 1. The hand-reared animals gained weight more slowly in the early stages of rearing but once weaned the differences were small and the growth curves suggest that the hand-rearing techniques developed are suitable for these species. Both mother-reared and hand-reared young showed a reduced rate of weight increase just after weaning.

Of the three species and compared with
other species hand-reared at Thumamah, such as Thomson’s gazelle *Gazella thomsoni* and Arabian oryx *Oryx leucoryx*, the Rheem are the most difficult to work with, particularly during the first days of hand-rearing.

Most of the animals reared during the two seasons have bred and the ♀♀ have reared their young. A two-year-old ♀ Rheem, which had been hand-reared, fostered an infant given to her three days after the birth of her own singleton. Adoption of another ♀’s young may occur in the wild but in this case it was certainly made possible by the relaxed nature of the mother. Some Rheem are still being handled on a regular basis for research work without showing any adverse effects. A few hand-reared ♂ Rheem do show some aggressive behaviour towards the keepers, a not uncommon side effect of hand-rearing, but the animals are still manageable.

Some of the hand-reared gazelles have been used in reintroduction projects in Saudi Arabia. Two adult ♂♂ and a number of offspring of hand-reared Rheem have been introduced into a 2300 km² fenced site containing other Rheem. Young from hand-reared Idmi have been reintroduced to an open protected area with other Idmi. As far as can be seen these animals show no differ-

ence in their ability to cope with the conditions compared with other gazelles.

Overall hand-rearing these gazelles has been successful and the experience gained could be a useful management tool, particularly if neonatal mortality is a problem (Kirkwood et al., 1987). Dealing with large numbers of young, however, is very time consuming.

**ACKNOWLEDGEMENTS**

We would like to thank the staff of KKWRG who gave up many hours to help with the rearing of the gazelles, in particular Ailsa Wood, Nombay Sayakkraghe and Nimal Dassanayake. Dr D. Williamson and Dr F. Rietkerk made useful comments on the manuscript. The project is funded by the National Commission for Wildlife Conservation and Development and without their support this work would not have been possible.

**PRODUCTS MENTIONED IN THE TEXT**

**Fercobsang 12**: iron supplement, manufactured by Vetoguino SA, Magny-Vernois, 70200 Lure, France.

**Baytril**: 5% injectable solution, manufactured by Bayer-Leverkusen, Germany.

**Depomycin 20/20**: manufactured by Intervet International BV, Boxmeer, The Netherlands.

**Pantetrovite**: multidose vitamin B and C injection, manufactured by Beecham Animal Health, Beecham House, Brentford, Middx, Great Britain.

**Sulfasol**: sulphasalimidine preparation, manufactured by Farvet Laboratories, Blade, The Netherlands.

**Milton**: sterilising fluid, manufactured by Richardson-Vicks Ltd, Egham, Surrey, Great Britain.

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The propagation and maintenance of the Arabian tahr

*Hemitragus jayakari*

at the Omani Mammal Breeding Centre, Bait al Barakah

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The Arabian tahr *Hemitragus jayakari* is a medium-sized, goat-like ungulate which is found only in the northern mountains of the Sultanate of Oman. It was listed as Endangered in the *Red Data Book* in 1972 (IUCN, 1972) and has remained in that category (IUCN, 1990). During the last 20 years, however, a number of steps have been taken to preserve the Arabian tahr within the Sultanate including, in 1974, the creation of the Wadi Serin Reserve around the Jebel Aswd, which lies south of Muscat, and, in 1976, protection by decree throughout the tahr’s range. In 1976–1978 Dr Paul Munton carried out field studies which were commissioned by the Diwan of Royal Court in conjunction with the World Wildlife Fund (now the World Wide Fund for Nature) and the IUCN. From these studies it was estimated that the world population stands at <2000 tahr. In 1976 His Majesty Sultan Qaboos bin Said decided that a breeding herd should be established, with a view to releasing suitable animals into protected wild areas, such as the Wadi Serin Reserve, in order to reinforce wild populations or to re-introduce the species into areas where it had been eliminated by hunting.

Despite the visual similarities between the Arabian tahr and the Himalayan tahr *Hemitragus jemlahicus*, particularly pelage length and colour, chromosome analysis has revealed that *H. jayakari* and the Nilgiri tahr *Hemitragus hylocrius* are related more closely, sharing a diploid number of 58 chromosomes compared with 48 in *H. jemlahicus* (Benirschke & Kumamoto, 1980, 1982). The Arabian tahr is the smallest of the three species and measurements taken of a wild ♂ just after its capture at Jebel Aswd in June 1989 were as follows: weight 38 kg; shoulder height 64 cm; body girth at centre 93 cm; horn circumference at base 15 cm; horn length over anterior curve 31 cm (cf. Prater, 1965). Adult ♀♀, 55–57+ cm at shoulder and weigh 17–20 kg or more.

In both sexes the coat is coarse and beige-brown relieved with body and facial markings, ranging from white through various shades of brown to black. The ♂’s

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