ond week does were turned out in the morning, returned at noon to clean and nurse their young, turned out again in the afternoon, and put in for the night in the evening. Generally, from the third week until fawns were weaned at three months, the dams were eager to get out in the mornings and were left out until evening. Any fawn handling or training could proceed as described by others (Reichert 1972, Parker et al. 1984).

HEALTH

The most common diseases encountered were of intestinal microbes causing diarrhea leading to rapid dehydration, emaciation, and death. Although Kramer et al. (1971) discussed the occurrence of *Escherichia coli* in mule deer, and Schwartz et al. (1976) found *Clostridium perfringens* to be a problem in pronghorn, our major concern was with *Coccidia* spp. Upon detection of this protozoan, 12.5% sodium sulfamethazine was used to prevent and treat the *Coccidia* infections. The drinking water was treated for two days with 8ml/l water (1 oz/gal) at time of birth, at one week postpartum (when the fawns begin drinking water), at two weeks, and anytime thereafter when loose or watery feces were noticed. A change in the character of the feces is the cue to an intestinal infection. For a more detailed discussion of the normal changes that the feces of young growing fawns undergo see Schwartz et al. (1976).

Although sulfamethazine is commonly used on livestock, Schwartz et al. (1976) noted that the drug may crystalize in the urine and kidneys of young animals. As an alternative they recommended the use of Sulfaquinoxaline. Sulfamethazine was effective in controlling diarrhea in all the nine fawns treated and we have, as yet, experienced no adverse effects. We do, however, recommend caution in the use of this drug.

In their evaluation of fawn-rearing procedures, Halford and Alldredge (1978) concluded that doe-reared fawns had no health advantage over those bottle-raised. They experienced 67% (6 of 9 total) mortality of dam-raised fawns to necrobacillosis (*Fusibacterium necrophorum*), whereas the mortality of hand-raised fawns was only 33% (3 of 9 total), entirely due to *E. coli* and *Streptococcus* spp. umbilical infections. Unlike the hand-raised fawns, however, 6 of the 9 dam-raised fawns (67%) were: (1) kept in pens with no forbs or grasses available, (2) at higher animal densities, and (3) nursing does that had been on deficient diets. As reviewed by Hibler (1981), necrobacillosis is often associated with poor range and crowded conditions. Therefore, the losses due to this disease, as well as many others, may well be averted under better conditions.

DISCUSSION

Over three years 14 fawns have been raised by does, and we bottle-reared 7 orphans. There was no notable difference in the tractability of the animals reared by these two methods, but there was a marked difference in favor of dam-reared fawns in their stature as yearlings and two-year-olds. This was particularly noticeable in those raised as singles rather than twins by their dam. If given a choice, raising singles is preferable. They exhibited a faster growth rate and were generally more robust than twins. In addition, the lactation drain on the doe was greatly reduced.

Our visual assessment agreed with Halford and Alldredge (1978), who reported significantly higher ($P < .001$) mean body weight and growth rates of fawns raised by their dam as compared to those bottle-reared. Our yearling bucks were equal to or larger in statur than the bottle-raised two-year-olds and wer of substantially heavier build than their bot tle-raised cohorts. A more quantitative indica tion of physical condition is the minimur breeding age of females (Mackie et al. 1982) Of two doe fawns sired by the same buck an raised concurrently, the dam-raised one gav birth to a fawn at one year of age. This is a rar occurrence and was not matched by her bot tle-fed half sister.

There are two major advantages of doe rearing fawns: (1) health—there is no subst tute for the dam's nurturing, species specifi colostrum, and doe's milk, which has twic the nutritional value of cow's milk (Sho 1981), and (2) time—time and inconvenienc spent in cleaning and preparing bottles thre to five times daily is eliminated, thus allowin more time for direct contact with the young.

It is unknown whether a key period for imprinting on a handler exists. Our fawns were first exposed to humans between 0 and 24 hours after birth. The animals were predominately handled by two people, yet were in frequent contact with others. Several authors stress the bond formation between handlers and bottle-raised young (Schwartz et al. 1976, Addison et al. 1983). Without the dependence on a handler for feed, the development of confidence between handlers and dam-reared fawns is very important. Initially, preferential behavior was exhibited toward the handlers; yet, amity or distrust did develop toward anyone with whom the animals had contact. The fawns' response to individuals gradually moderated through their first year.

The work reported herein was done with fawns born to tractable does. The presence of tame conspecifics eases the handling of new animals (Kreulen 1977). Some species, though, may not be suited for this method of rearing. As part of a project involving white-tailed (*Odocoileus virginianus*), mule, and black-tailed (*O. h. columbianus*) deer in New Hampshire, an effort was made to raise two sets of twin white-tailed deer fawns on their dams. The does were the most tame of the herd; however, their fawns were never approachable despite constant human contact. One set eventually brought about their own deaths in panicked flight (P. Pekins, personal communication). In time the adaptable species will be known. Until then dam-raising young should be considered as an option when rearing animals for ecological studies.

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Literature Cited

ADDISON, E. M., R. F. MCLAUGHLIN, AND D. J. FRASER. 1983. Rearing moose calves in Ontario. Alces 19: 246–270.

HALFORD, D. K., AND A. W. ALLDREDGE. 1978. A method for artificially raising mule deer fawns. Amer. Midl. Nat. 100: 493–498.

HIBLER, C. P. 1981. Diseases. *In* O. C. Wallmo, ed., Mule and black-tailed deer of North America. University of Nebraska Press, Lincoln. 605 pp.

HOBBS, N. T., AND D. L. BAKER. 1979. Rearing and training elk calves for use in food habits studies. J. Wildl. Manage. 43: 568–570.

HUTCHISON, M. 1970. Artificial rearing of some East African antelopes. J. Zool. 161: 437–442.

KNORRE, E. P. 1974. Changes in the behavior of moose with age and during the process of domestication. Le Naturaliste Canadien 101: 371–377.

KRAMER, T. T., J. G. NAGY, AND T. A. BARBER. 1971. Diarrhea in captive mule deer fawns attributed to *Escherichia coli*. J. Wildl. Manage. 35: 205–209.

KREULEN, D. K. 1977. Taming of wild-captured wildebeeste for food habit studies. J. Wildl. Manage. 41: 793–795.

MACKIE, R. J., K. L. HAMLIN, AND D. F. PAC. 1982. Mule deer. *In* J. A. Chapman and G. A. Feldhammer, eds., Wild mammals of North America—biology, management, and economics. Johns Hopkins University Press, Baltimore. 1,147 pp.

PARKER, K. L., C. T. ROBBINS, AND T. A. HANLEY. 1984. Energy expenditures for locomotion by mule deer and elk. J. Wildl. Manage. 48: 474–487.

REICHERT, D. W. 1972. Rearing and training deer for food habits studies. U.S. For. Serv., Rocky Mtn. For. Range Exp. Stn. Res. Note RM-208.

SCHWARTZ, C. C., J. G. NAGY, AND S. M. KERR. 1976. Rearing and training pronghorns for ecological studies. J. Wildl. Manage. 40: 464–468.

SHORT, H. L. 1981. Nutrition and metabolism. *In* O. C. Wallmo, ed., Mule and black-tailed deer of North America. University of Nebraska Press, Lincoln. 605 pp.

SUBSPECIFIC IDENTITY OF THE AMARGOSA PUPFISH, *CYPRINODON NEVADENSIS*, FROM CRYSTAL SPRING, ASH MEADOWS, NEVADA

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ABSTRACT.—Samples of pupfish from Crystal, Marsh, and Point of Rocks springs, Ash Meadows, Nevada, were examined to determine the subspecific identity of *Cyprinodon nevadensis* presently inhabiting Crystal Spring. Meristic and morphometric analyses indicate that Crystal Spring is inhabited by *C. n. mionectes*. The presence of this subspecies is most likely explained by their precarious survival in the spring's outflow after they were eliminated by transplanted largemouth bass in the spring pool, and their subsequent reestablishment throughout the spring system after the extirpation of the bass.

Crystal Spring (= Big Spring of Miller 1948) is the type locality for the Ash Meadows pupfish, *Cyprinodon nevadensis mionectes* Miller. Crystal Spring was chosen by Miller (1948) as the type locality because its pupfish population "has characters which very closely approach the average for the subspecies as determined by an analysis of all populations." In recent years, however, the subspecific identity of the pupfish in Crystal Spring has been questioned.

On 1 January 1966, J. E. Deacon, C. L. Hubbs, and R. R. Miller searched Crystal Spring for pupfish and found none (J. E. Deacon, field notes; Miller 1969). However, at least 10 transplanted largemouth bass, *Micropterus salmoides*, were seen in the main spring pool. The pupfish population "reappeared" by early February 1975 (Liu and Soltz 1983) and was later described as in "fine shape" with a population of approximately 1,500 pupfish (Hardy 1980).

Two subspecies of *Cyprinodon nevadensis* occur in Ash Meadows. In addition to its presence in Crystal Spring, *C. n. mionectes* occurs in a variety of lower-elevation springs (Miller 1948, Soltz and Naiman 1978). Among other springs, *Cyprinodon n. mionectes* occurs in Jack Rabbit, Point of Rocks, the Bradford Springs, and springs at the northern end of Ash Meadows that discharge water into the formerly vast Carson Slough area. Several of these springs, and an introduced population of *C. n. mionectes* at Collins Ranch (Baugh et al., in press), are within 3 km of Crystal Spring. *Cyprinodon n. pectoralis* also occurs in nearby springs, such as Indian, Marsh, School, and Scruggs. The population of *C. n. pectoralis* from Indian Springs was particularly suspect as a source for the Crystal Spring population because that spring's outflow frequently discharges into the outflow of Crystal Spring. Both subspecies of *Cyprinodon nevadensis* are listed as endangered by the U.S. Fish and Wildlife Service.

The potential for surface water connection among the various springs is compounded by periodic flash floods, which may distribute pupfish some distance from their usual habitat, and by the formation of Crystal Spring Reservoir, which is fed by outflow water from Crystal Spring.

Thus, at least three hypotheses can be employed to explain the recurrence of pupfish in Crystal Spring:

1. pupfish from another spring reached Crystal Spring by surface water connection,
2. pupfish from another spring were introduced into Crystal Spring by man, or
3. the pupfish in Crystal Spring were not eliminated by the largemouth bass but only reduced to such low numbers that they appeared to be extirpated.

Because of the geographic proximity of other springs, either of the first two hypotheses could explain the presence of either *C. n*

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