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EFFECTS OF FERAL GOATS (CAPRA HIRCUS) ON ALDABRA ATOLL

BY

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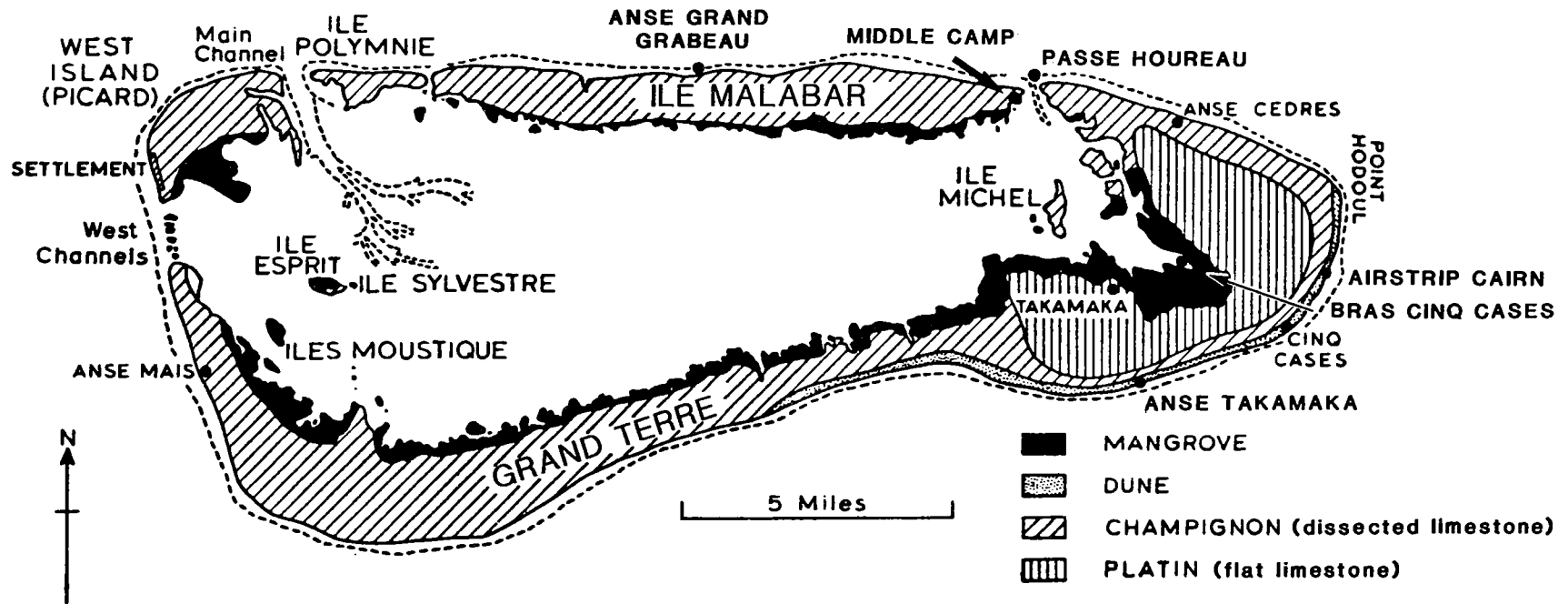
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INDEX MAP OF ALDABRA ATOLL

(after D.R. Stoddart and C.A. Wright, 1967, Nature V. 213 No. 5082)



EFFECTS OF FERAL GOATS (*CAPRA HIRCUS*) ON ALDABRA ATOLL

BY

BRUCE E. COBLENTZ¹ AND DIRK VAN VUREN²

The origins of goats on oceanic islands are diverse and often poorly documented. For most populations, the date and purpose of introduction remains uncertain (reviewed by Coblentz 1978), and in any event, pales by comparison with the ecological consequences.

The earliest documented introduction of goats to an oceanic island was probably that onto St. Helena where the initial introduction occurred either in 1502 (Darwin 1860) or 1513 (Wallace 1911). The extensive damage to native vegetation resulted in an order, issued in 1731, that all stray animals should be destroyed (Darwin 1860). Nevertheless, by 1810 the island was reduced from a heavily forested condition to an oceanic rock (Darwin 1860, Wodzicki 1950). An important point concerning the destruction of the endemic forests of St. Helena was that it took a little over 200 years for the destruction to be completed (Darwin 1860). When the last of the mature trees fell, the seed sources were gone forever. In contrast, goats have only been present on Aldabra for a little more than 100 years (Stoddart 1981).

Published descriptions of the effects of feral goats in insular ecosystems have been nearly universally negative, often dramatically so (reviewed by Coblentz 1978), including destruction of native vegetation, extinction of preferred forage species, prevention of seedling regeneration, accelerated soil erosion, and numerous indirect effects upon endemic fauna, up to and including extinction (for example, Greenway 1958).

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Because of its finality, extinction seems to take precedence in the manner in which we view the effects of feral goats; however, it is to those insular species threatened, but not yet extinct that attention needs to be directed. Although a relatively few island species have been driven to extinction by feral goats (but see Thorne 1967), probably a great many more have a precarious status that is oftentimes unnoticed. High levels of grazing pressure, in addition to negative effects on favored plant species, may have dramatic effects upon invertebrate communities (Hutchinson and King 1980); the effects of feral sheep have been shown to produce marked effects upon insular avifaunal communities (Van Vuren and Coblentz 1987).

GOATS ON ALDABRA - BACKGROUND

Goats have been present on Aldabra (46°20' E. Long., 9°24' S. Lat.) since sometime prior to 1878 (Stoddard 1981); however, it is only in recent years that their presence has been viewed with alarm, and then only by some of the biologists visiting the Atoll. Although there is uncertainty about goat numbers on the Atoll during the past 100 years, they apparently have not achieved the spectacularly high densities on Aldabra as they have on other, more productive oceanic islands. However, Dupont (1929, cited in Stoddard 1981) mentioned "hundreds of them" in 1916 and "several thousands" by August 1929.

Goat numbers on Aldabra appear to have been relatively low in the past several decades (Stoddard 1971, Gould and Swingland 1980) except that they have increased markedly on Grande Terre, the largest island of the Atoll, in the past several years. Total goat numbers on Aldabra increased from an estimated 500-600 individuals in 1976-77 (Gould and Swingland 1980) to as many as nearly 1300 (Gould-Burke, M. 1986, paper given at International Aldabra Workshop, Smithsonian Institution) in 1985. The increase in goat numbers prompted concern from several biologist that some elements of the endemic Aldabra biota would be severely impacted by high levels of herbivory imposed by the goats.

Our project was precipitated indirectly by the report of Newing et al. (1984) in which data were presented indicating that goats were greatly increasing on both Ile Malabar and Grande Terre, and that on Malabar goats were spreading westward into previously unoccupied areas which were the sole habitat of the endangered Aldabran brush warbler (Nesillas aldabranus). In addition, although there were far more goats on Grande Terre than on Malabar, few researchers other than Newing et al. (1984) felt that there was any significant competition between the endemic giant tortoise (Geochelone gigantea) and the goats, although this belief seems to have been based primarily upon comparison of food habits (for example, Gould and Swingland 1980).

Thus, our project was instituted as a pilot project. Our objectives were to 1) eradicate, if possible, all goats from Ile Malabar, 2) determine if eradication of goats was possible from the entire Atoll, and 3) determine subjectively the effects of goats on major portions of the Aldabran biota. The results of objectives 1 and 2 are reported elsewhere (Coblentz and Van Vuren, 1987 unpublished report to Seychelles Islands Foundation); this paper reports our findings concerning objective 3.

EFFECTS OF GOATS ON ALDABRA

We were on Aldabra 30 January through 8 March 1987. On Ile Malabar, all accessible areas between Passe Houreau and a point about 0.5 km west of Anse Grand Grabeau were searched for goats and goat sign. Goats were shot whenever observed, and areas having sign or where goats were heard but not seen were searched repeatedly until individuals were located and killed. Subjective evaluations of goat impacts were made continuously as areas were searched for goats and sign. On Grande Terre, all habitats in an area between the lagoon at Bras Cinq Cases and the coastline from roughly 1 km north of the airstrip cairn, south and southwest nearly to Anse Takamaka, were searched for goats and examined for their effects.

Environmental damage due to goats on Ile Malabar was judged to be light. Significant effects of goats, primarily as browse lines on preferred forage species, were observed in only a few localized areas. The heaviest goat damage, and the largest area of contiguous goat habitat, was in the Middle Camp area, and much of it probably originated in past years when the population was higher (>76 in 1976-77, Gould-Burke, M., 1986, paper given at International Aldabra Conference, Smithsonian Institution, vs 32 in this study). However, even at Middle Camp there were many shrubs available to tortoises, and tortoises were frequently observed browsing.

Feral goats are severely damaging the Grande Terre ecosystem; that was immediately evident to us as we began hiking inland from Bras Cinq Cases on the lagoon side of the island. We noticed that goat sign was abundant well into the mangroves (from the land side), and that a virtually continuous browse line nearly 2 m in height was present. Even a considerable amount of Pemphis acidula had been completely browsed to this height, and numerous individuals had been killed.

Perhaps the greatest shock was our observation of hundreds of tortoises in intertidal areas where no herbaceous vegetation was present. At low tide we observed these tortoises to forage on the few leaves that fell to the ground, and to seemingly feed on algae on the surface of the mud. At high tide the tortoises refuged on rocks, mangrove prop roots, and dead limbs, simply to avoid being swept away; many were observed in the red mangrove (Rhizophora mangle) zone. It was obvious that this was a marginal, high risk habitat for tortoises, and it seemed likely that resource limitation further inland had probably been the impetus for such extensive utilization of intertidal areas.

Further inland, virtually all individuals of favored woody plant species exhibited a high browseline, and regeneration of these species was simply nonexistent. There have been several explanations offered for the dramatic changes in the flora of Grande Terre, and inexplicably they seem to search for reasons other than the goats. For example, it has been suggested that some high browselines were caused by tortoises piling up 2 and 3 layers thick while seeking shade. Presumably in such a situation a tortoise would be able to reach leaves that were not normally available. The death of large numbers of some species, for example, bois cassant (Guettarda) has been attributed both to tortoises abrading the roots while seeking shade, and to salt spray during storms. Perhaps these hypotheses are

correct; however, they fail to account for the complete absence of seedling regeneration, and the complete defoliation of all branches less than 2 m high. These trees all have high browselines caused by goats, and are not repopulating because seedlings cannot survive, even in areas where tortoises cannot go. Additionally, it seems unlikely that any strand species is intolerant of exposure to salt.

We do not propose that goats are solely responsible for major vegetation changes on Grande Terre, but rather that they are one major factor among several possible causes. Tortoises and their forage resource on Aldabra may well fluctuate greatly over time; it will take many years to determine if this is the case. Goats, however, greatly increase total consumption of plant biomass, and compete directly and indirectly with the tortoises for food. We believe that the impact of goats on Aldabra is additive to that of the tortoises, and magnifies the amplitude of fluctuation in numbers of both plants and tortoises, increasing the chances of extinction of the most sensitive endemics.

Changes in woody vegetation on Grande Terre are a good example of the effect of goats. Several authors (Hnatiuk et al., 1976; Merton et al., 1976; Swingland and Coe, 1979; Gould and Swingland, 1980) have presented compelling arguments that attribute recent changes in the vegetation on Grande Terre to feeding and resting activities of tortoises. The negative effects of tortoises are irrefutable; however, we believe that these effects do not account for all the damage observed. In fact, we strongly disagree that the tortoise is the "only significant primary consumer" (Coe et al., 1979) and that "The impact of feral goats on the giant tortoise is minimal on Aldabra" (Gould and Swingland, 1980). In some areas, goats probably contribute significantly to the death of shrubs, and more importantly they play a key role in preventing all regeneration of preferred woody species. Furthermore, we are certain that the nearly 2 m high browseline observed on Grande Terre is attributable solely to goats. Since tortoises presumably evolved with the vegetation of the island, it seems likely that the plant species are capable of regeneration in the presence of tortoises, at least in refugia where the tortoises cannot get to them. Goats represent the only additional major source of herbivory on Grande Terre, and are capable of going where tortoises cannot. It would seem logical to attribute the complete lack of seedling regeneration to them.

One factor supporting our argument that goats are currently a major competitor for forage on Grande Terre is the density of goats we observed. Gould and Swingland (1980) reported a density of 10-12 goats/km² in the southeast portion of Grande Terre. Working in the same area, we killed 292 goats in an area of about 8-10 km², and many more remained alive. Thus, there were in excess of the 29.2-36.5 goats/km² based on kill figures alone, a minimum three-fold increase in the decade since the 1977 (Gould and Swingland, 1980) estimate.

By contributing to the accelerated death of trees and shrubs, and preventing all seedling regeneration, goats may be severely limiting the amount of shade available to tortoises. Additionally, as foliar area of a plant is reduced through browsing, the number of tortoises that can refuge under that plant is proportionately reduced; excess tortoises need to find a new source of shade. In some areas, sources

of shade are far apart and essentially fully utilized, thus tortoises forced to seek new shade probably have a low probability of survival. The effects of goats upon the shade resource may actually be a greater influence upon tortoise numbers and condition than direct competition for food.

Accordingly, we have concluded that there should no longer be any question of whether goats should be eradicated, but rather a question of how soon it can be implemented. Together we have many years of experience with feral ungulates on oceanic islands, and we judged the impacts of goats on Grande Terre to be as serious as other islands where goats have been viewed as agents of habitat degradation and extinction of endemic species. Quite clearly in our minds, goats on Grande Terre are altering the species composition of both fauna and flora, reducing the forage resource available to tortoises, eliminating seedling regeneration, reducing shade available to tortoises, and probably reducing biotic diversity.

On St. Helena, it took over 200 years before "the evil was complete and irretrievable" (Darwin 1860). Aldabra would better be remembered as testimony for successful preservation of insular biota, rather than a requiem for one of the world's truly unique ecosystems.

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