Hybridisation among Deer and its implications for conservation

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INTRODUCTION

The Red Deer (*Cervus elaphus scoticus* Lonnberg, 1906) is generally considered to be the only native hoofed animal that has lived contemporaniously with man in Ireland (Charlesworth, 1963 and O'Rourke, 1970). Ecologically, the red deer appears to be an animal of the transition zone between forest and steppe (Dzieciolowski, 1969) and it was widely distributed in Ireland up to the mid-eighteenth century (Pococke, 1752; Moryson, 1735 and Scouler, 1833). The present distribution of the species in the wild is however confined to three of the thirty two counties of Ireland and only in County Kerry are the deer considered to be indigenous. The other two counties, Wicklow and Donegal, have stock of mainly alien origin.

There is a general recognition of the threat that an alien red deer stock could present to the genetic integrity of the Irish race of red deer in county Kerry if these two red deer stocks were brought into contact. However, until recently few people realized that, in areas where red deer and the exotic Japanese sika deer (*Cervus nippon* Temminck) are living sympatrically (within the same geographical area) as in County Kerry, there is any threat of the two species hybridising.

A current ecological study of red deer and sika deer in County Wicklow has produced evidence that clearly supports the early reports made by Powerscourt (1884), Brooke (1898) and F. W. B. (1902) that red deer and sika deer can hybridise freely. The evidence also indicates that hybridisation between these species is an insidious phenomonen which can result in an apparent total amalgamation of a red deer population during a relatively short period of time.

The objective of this paper is to relate the past history and present status of the hybridisation between sika deer and red

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deer in the County of Wicklow with a view to alerting all concerned with the conservation of these and other species of the genus *Cervus* to the implications of hybridisation.

ORIGINS OF HYBRIDISATION

It appears that the racial integrity of the red deer in County Wicklow began diminishing as early as 1244 when the Norman barons introduced alien red deer to their deer forest at Glencree (Le Fanu, 1893). There appears also to be little doubt that additional introductions were made up to the mid-nineteenth century. In 1858-1859 Viscount Powerscourt experimented with the introduction and acclimatization of various animals which he thought might be ". . . . ornamental as well as useful in Deer-parks in the United Kingdom," at his estate at Enniskerry, County Wicklow. In his report of the experiments in 1884 he wrote that he initially introduced three species of deer; several colour varieties of red deer, (*Cervus elephus hippelaphus* Erxleben), sambur deer (*Cervus unicolor*), axis deer (*Axis axis*) and several colour varieties of red deer (*Cervus elephus* L.) including the sub-species wapiti deer (*Cervus elaphus canadensis* Erxleben). After finding his 100 acre deer enclosure too small, he transferred all the deer to a newly built deerpark on his estate. Then in ". . . . about the year 1860 . . . ." he introduced for the first time, to either Britain or Ireland, Japanese sika deer (*Cervus nippon* Temminck). These deer, one stag and three hinds, were also placed in the deerpark where no attempt was made to separate the varous species.

Powerscourt also reported that several red x sambur deer hybrids were born and that the sika deer, ". . . have undoubtedly interbred with the Red Deer; there are three of four Deer in the Park here which are certainly hybrids, the Red hind in each case being the dam." F.W.B. (1902) also reported seeing red x sika deer hybrids in the Powerscourt deer park. The sika deer were very successful and in 1884 report, Powerscourt wrote that he had ". . . . upwards of 100 of them, besides having shot two or three yearly, and also having given away a great many and sold others." This included the introduction of some sika deer to Colebrooke, county Fermanagh and Brooke wrote in 1898 that he observed at least one instance of red deer and sika deer hybridising there. Red deer and sika deer hybridisation has also been reported in at least four separate areas of Britain (Whitehead, 1964; Delap, 1967; MacNally, 1969 and Blair, 1972).

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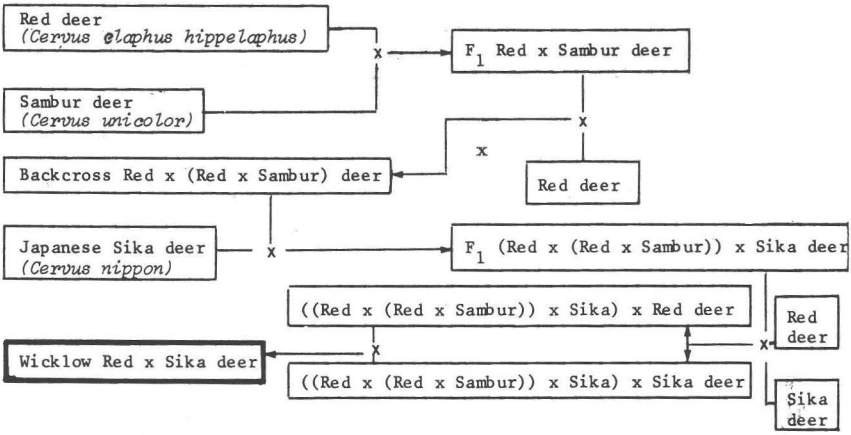

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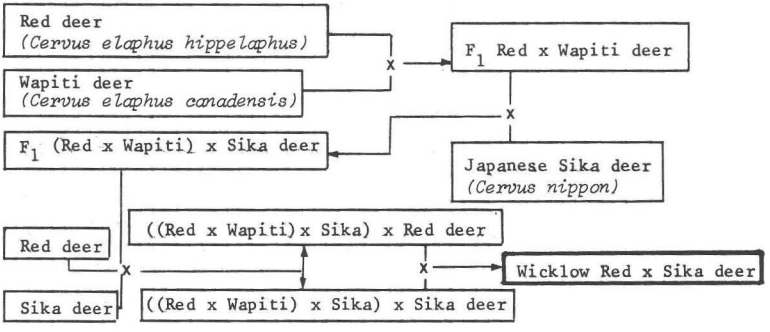

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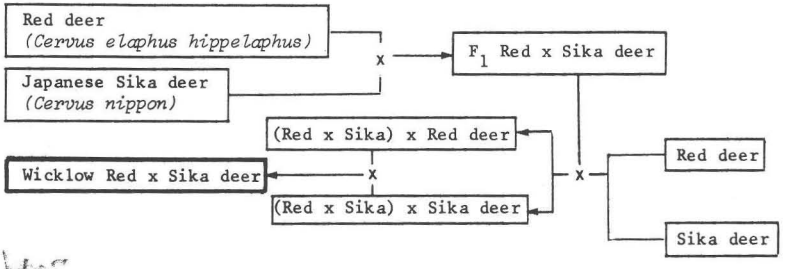

Figure I

Three possible combinations of Red deer *(Cervus elaphus hippelaphus)* Sambur deer *(Cervus unicolor)* and Japanese Sika deer *(Cervus nippon)* that may have initiated the present Wicklow Red x Sika deer hybrid population.

Red deer and sika deer differ considerably in size and to a lesser extent in mating behaviour. The question of how these two species first hybridised is unfortunately not easy to answer. It appears that there has never been any controlled mating of these species. However, Brooke (1898) wrote: "In July, 1896, a tame red deer hind dropped a hind calf to a Japanese deer stag." As this sika deer stag came originally from the Powerscourt deerpark after hybridisation had already occurred, the genetic constitution of the sika deer stag can be suspected of having some red deer genes. Knowledge of the circumstances which led to the initial hybridisation of sika deer and red deer at the Powerscourt deer

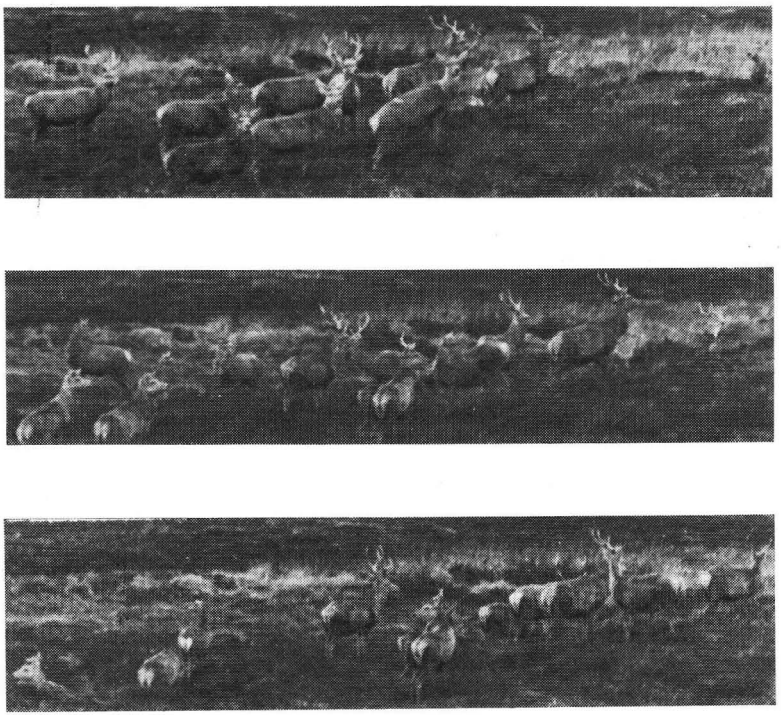

Figure 2

Three views of a group of red x sika deer hybrid stags in May 1973. They are typical of the deer in the non-forested areas of Wicklow which show a wide variety of red deer and sika deer characters.

park seems impossible to obtain as there were three species of the genus *Cervus* together in the park; red deer (including wapiti deer) sambur deer and sika deer. Although Powerscourt claimed to have removed the wapiti deer, and that the sambur and red x sambur deer hybrids had died out, it was still quite possible that some sambur deer or wapiti deer genes remained among the red deer. Thus it was equally possible that the initial hybridisation was between a red x sambur deer hybrid or a red x wapiti deer hybrid and a sika deer, as it was between a pure red deer and a sika deer (Fig. 1).

Red x sika deer hybrids have not been observed in County Kerry where some 200 red deer and more than 1000 sika deer are living on the same range (Larner, 1972). The question of why hybridisation occurred at the Powerscourt deerpark and not in County Kerry arises. However, an examination of two major differences that exist between the two situations may provide the answer. Firstly, as the county Kerry red deer are most likely of native stock they have evolved in greater geographical isolation from the central European red deer than those from the Powerscourt deerpark. Therefore with less mixing genetically the county Kerry red deer may be less compatable, reproductively, with sika deer.

Secondly, the forced confinement of the red deer and sika deer in the Powerscourt deer park was important in increasing the opportunities for hybridisation. However, this may not be a primary factor as hybridisation has been reported to occur in the wild in Scotland (MacNally, 1969) and natural hybridisation has been reported to occur between sika deer and the Asiatic red deer in areas where they are living sympatrically. (Corbet, 1966; Mirolyubov and Ryashchenko, 1948). Thus it is likely that the origins of hybridisation between red deer and sika deer are due to a number of factors rather than any single one and the reason for the apparent delay in its occurring in county Kerry is because the required combination of factors has not yet presented itself.

THE COUNTY WICKLOW HYBRID DEER POPULATION

It appears that the present Wicklow deer population originated mainly from stock that escaped from the Powerscourt deerpark during the troubled period around 1922 (Whitehead, 1964). Both

the red deer and sika deer (including red x sika deer hybrids) established themselves successfully in the Wicklow region. Little effort was made until recently to study these deer although various reports of their distribution and members were made during the intervening years by Delap, 1936; Lang, 1970 and Mulloy, 1970.

The current ecological study of the red deer and sika deer in Wicklow was initiated early in 1972 in response to forest requirements relating to management, recreation and conservation. Field work for this recent study commenced in June 1973. The initial work consisted of accurately censusing the deer inhabiting the non-forest areas and mapping the distribution of all deer in county Wicklow and adjacent counties. During the initial observation of the deer in Wicklow it became apparent that morphological and colour characteristics of the deer under observation in non-forested areas were in no way specific for either red deer or sika deer. Hybridisation between the two species was obviously occurring.

At present there are about 250 red x sika deer hybrids inhabiting the non-forested area of the mountains and a subjective estim-

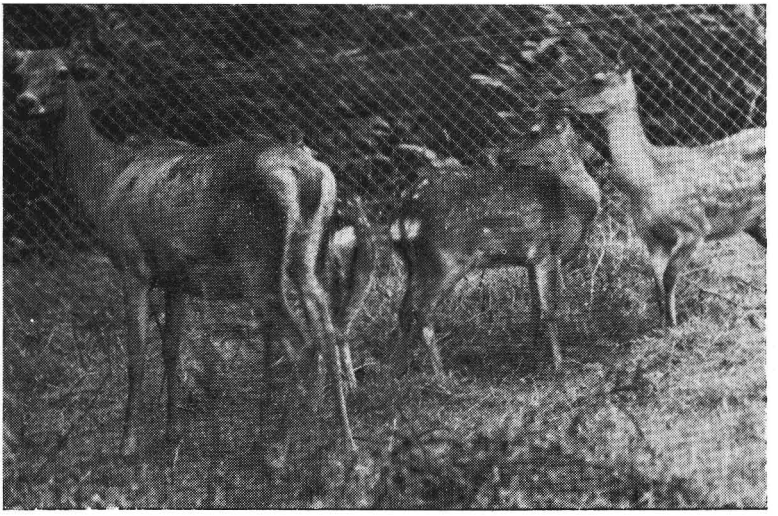

Figure 3

Left; female red deer (**Cervus elephus**), right; female sika deer (**C. nippon**) both showing the diagnostic characters summarised in Table 1.

ate of the sika-deer-like population inhabiting the forested areas, based upon distribution, sightings and carrying capacity, is about 3,000 deer.

Just over 200 deer have been observed closely in non-forested areas of Wicklow. They have been described on the basis of characteristics specific to red deer or sika deer (Table 1). Preliminary analysis of these observations show that approximately 50-60% of the deer were obvious red x sika deer hybrids (example, Fig. 2), 10% were mostly red-deer-like and 30 % were very sika-deer-like. Generally, the specific morphological and colour characteristics of red deer and sika deer tend to coalesce and combine in the Wicklow hybrid deer population. This has resulted in the production of individuals varying widely in both colour and form. This suggests that the introgression of the red deer and sika deer was complete many years ago and that no red deer are now present in the Wicklow region.

None of the Wicklow deer observed so far during the present study has shown only red deer characteristics. However some sika-deer-like animals have proved very difficult to distinguish from sika deer. Indeed the extent of hybridisation occurring within the Wicklow sika deer population remains unknown. This investigation may require the use of biochemical techniques. However, it appears that the problem of determining whether deer are hybrids or not can be solved in Wicklow if observations are made on the following morphological and colour characteristics.

(1) There always appears to be some evidence of the sika-deer-like metatarsal gland, even though there may be only a small clump of white hairs.

(2) In hybrids the rump patch does not extend forwards as far as in red deer. (See Table 1).

(3) The facial profile of red-deer-like hybrids is shorter than that of pure red deer.

Although these three features appear useful in determining red and sika deer hybrids in Wicklow, red-deer-like hybrids may be possible to identify in the field areas where introgression is complete. In these situations the dilution of sika deer genes may be so great that only biochemical techniques may determine whether red-deer-like animals are pure or not.

Although behavioural data on the red sika deer hybrids are as yet exiguous some general patterns of behaviour are nevertheless apparent. Principally, there appears to be a clinal variation in behaviour within the hybrid population that ranges from almost

TABLE 1

MORPHOLOGICAL AND COLOUR CHARACTERISTIC DIFFERENCES BETWEEN ADULT RED DEER AND JAPANESE SIKA DEER*

(See also fig. 3)

Character	*Red deer*	*Japanese Sika deer*
Shoulder height	Stag 42-50 inches Hind 40-46 inches	Stag 32-36 inches Hind 30-32 inches
Winter coat	Greybrown or dark brown	Stag, dark grey to black Hind, grey to dark grey Both sexes may show faint spotting.
Summer coat	Light reddish brown to dark brown—occasionally a row of white spots on either side of dorsal stripe	Light reddish brown to dark brown with numerous white spots running in roughly aligned rows along flank.
Rump patch	Off-white to light brown heart shaped patch extending to top of pelvis	White, not extending above base of tail, bounded by black expands to large conspicuous patch when alerted.
Tail	Short, usually same colour as rump or slightly darker	Long white, with black dorsal stripe, helps to conceal white rump patch when unalerted.
Ear	Long, dense white hair inside, surrounded by dark margin	Rounded, fine white hairs inside on pink flesh with black thumb print on lower edge. Hairs very short in Summer
Metatarsal gland	Small, 1 inch diam., light to dark brown or same colour as surrounding hair and almost as long	Large 1×2 inches, white and odoriferous and hair almost twice as long as surrounding hair.
Profile	Long tapering snout	Short tapering snout.
Antlers	Up to 12 or more points, angle of brow tine to main beam usually greater than 90° and branching out from top of coronet, first top points usually pointing to front and rear of animal	Usually up to 8 points, angle of brow tine to main beam less than 90° and branching out 1-1½ inches from top of coronet, first top points pointing to sides of animal.
Velvet	Dense covering of fine dark brown or black hairs, also silver hair on pink flesh	Dense covering of very fine and short black hairs, wax like appearance, pink flesh showing in places.

*From: Kiddie, 1962; Whitehead, 1964 and author's measurements.

typical red deer behaviour in non-forested areas to behaviour typical of sika deer in forested areas. It is also clear that the sika deer population is rapidly expanding its already wide distributtion (Fig. 4).[1]

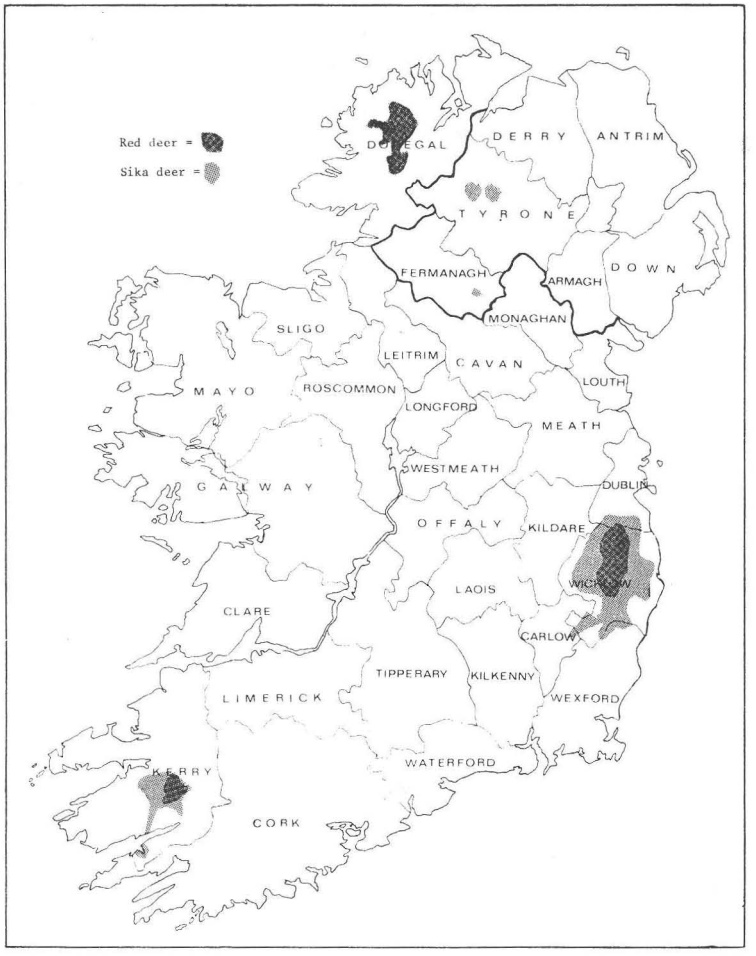

Figure 4

Distribution of red (**Cervus elephus**) and sika deer (**C. nippon**) in Ireland.

1. The Donegal red deer have recently extented their range into County Fermanagh and are now sympatric with the sika deer in the vicinity Brookeborough, Co. Fermanagh.

Recent information from the Great Glen area in Scotland indicates that the sika deer population there is also expanding and rapidly colonising new areas (MacNally, 1973). This dispersal behaviour is in marked contrast to that of the sika deer in Co. Kerry, Wareham (Dorset) (Horwood 1972), and in other areas where hybridisation has not yet been recorded or at least only recently. As red deer are known to be good colonists (Wodzicki, 1961), it is likely that it is the influence of red deer genes within the sika-deer-like population that causes them to disperse more rapidly in areas where hybridisation occurs. This theory is supported by the numerous reports that continue to be received by the Wicklow deer research team, of sika-deer-like hybrids being seen in the most recently colonised areas and at the edge of the sika deer's distribution there. The presence of these sika-deer-like hybrids in these newly colonised and boundary areas has been confirmed by close examination of shot animals. These observations are also a further indication of how insidious is hybridisation between red deer and sika deer.

CONTROLLED CROSS BREEDING AND HYBRIDISATION

As stated earlier the exact origins of the hybridisation between European red deer and Japanese sika deer are unknown and as there appears to be no record of the controlled crossbreeding of the two species, the characteristics of the F1 hybrid are unknown. Hence, a series of controlled cross breeding experiments between red deer, sika deer and red x sika deer hybrids was started in September, 1972. It is hoped that the results from these experiments will provide vital clues to the factors which led to the initial hybridisation of the two species. It is also expected that the resulting offspring of known parentage will act as a reference of morphological and colour characteristics that can be used in recognising the relative proportions of red deer and sika deer genes present in the Wicklow deer population. This reference would also aid the identification of red x sika deer hybrids in areas where the control of red deer x sika deer hybridisation might be attempted.

Table 2

Cross-breeding e experiments between Red deer (**Cervus elaphus hippelaphus**), Sika deer (**Cervus nippon**) and red x sika deer hybrids.

1 Red deer stag x 4 Sika deer hinds 3 Sika deer stags x 4 Red deer hinds	Started in March, 19723.
1 Red x sika deer x hybrid stag	3 Red deer hinds—started in November, 1972. one male calf born 1 Sept., 1973. 3 Sika deer hinds—Started in 1973

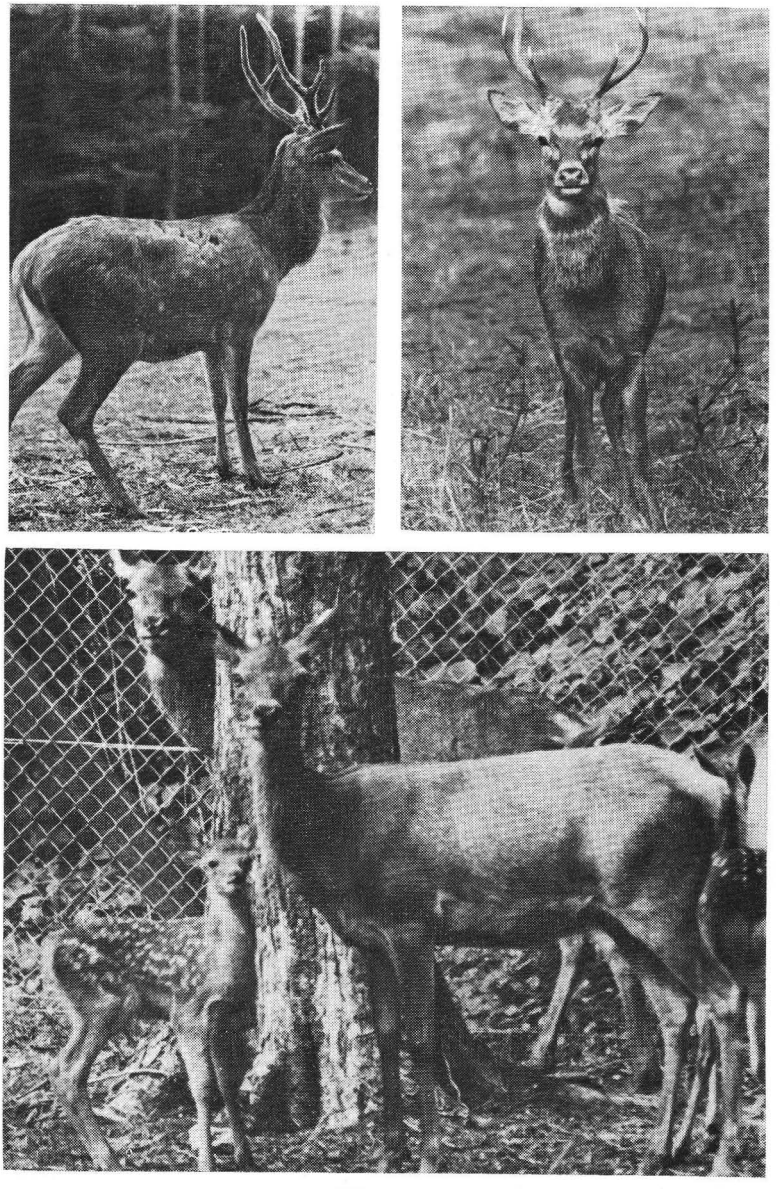

Figure 5

Photographs of hybrid stag (top left and right) red deer hinds, sika deer hinds, and the (red x sika) x red deer calf born on 1st September 1973 (bottom).

Initially four hybridisation crosses are being made, as outlined in Table 2. On 1st September, 1973 the first calf was born (Fig. 5). This was the result of a cross between a red deer hind (seven years old 1972/73) and a red x sika deer hybrid stag (two years old 1972/73). This calf shows only faint hybrid characteristics, principally, a low rump patch and a light coloured metatarsal gland, some of the hairs of which are white. The white spots that dapple the flanks of this calf are not in the obvious horizontal alignment that is usual for red x sika deer calf hybrids and sika deer calves in the Wicklow region, neither are the ears in any way sika-deer-like. However, as this is only a calf, the mature characteristics may be more obviously hybrid. Nevertheless, it is interesting that the red deer characteristics appear so dominant over that of the paternal hybrid characteristics. Should this be a rather consistent trend it is very likely that once red x sika deer hybrid genes are introduced into a red deer population their detection is almost impossible by visual means.

In the early literature on red deer and sika deer hybridisation it was generally stated that the crossing occurred between a red deer hind and a sika deer stag (Powerscourt, 1887 and Brooke, 1898). However, the sika stag (standing about 34 inches at the shoulder) is often considered too small to physically mate a red deer hind (standing about 42 inches at the shoulder). Indeed it would seem quite impossible when these two species are seen together. Nevertheless, the height difference is overcome by the ability of the red deer hind to accommodate herself to the shorter stag by bending her rear legs. While there seems no physical impediment for union between a sika deer hind and a red stag there appears to be mating behavioural differences between the two. It is hoped that the controlled breeding experiments will indicate that combinations are behavourally compatable.

HYBRIDISATION; ITS THREAT TO GENE POOL CONVERSATION

Information on the hybridisation of red deer and sika deer is limited by the scarcity of observational and experimental work, and by the relatively short period the ecological study of the deer in Wicklow has been in progress. Evidence that these two species hybridise, based on their morphological and colour characteristics is conclusive. It is also evident that red deer x sika deer hybridisation is an insidious and extensive phenonomen which leads to the complete destruction of the genetic integrity of at least the red deer population and, possibly, that of the sika deer population. The hybridisation of these two species in Wicklow is not an

isolated phenomonen but has also occurred widely in Britain, in nearly all areas where red deer and sika deer are living sympatrically (Blair, 1972; MacNally, 1969; Whitehead, 1964 and Delap, 1968).

Genetic and ecological research has shown that the genetic integrity of species, subspecies and genetically distinct gene pools of plants and animals are worthy of conservation (Frank *et al*, 1970 and Des Vos, 1956).

However, the conservation of genetically distinct populations requires that they may be protected not only from extermination but also from amalgamation between closely related and reproductively compatible groups. This latter threat may be the greater of the two in present times.

Although natural amalgamations can occur when geographical barriers are eliminated between closely related but allopatric (occupying geographically separated areas) populations resulting in a clinal variation between the two original parent populations (Sinnott *et al*, 1952 and Mayr, 1966), man has induced many artificial amalgamations by his direct and indirect actions. In the past many different exotic and indigenous gene pools of red deer and sika deer were amalgamated to promote larger antlers and to maintain novel varieties (Lowe, 1961 and Kiddie, 1962). These introductions and amalgamations were widespread in Britain and Ireland and have led to the almost complete destruction of the genetic integrity of red deer in Britain and Ireland (Lowe, 1961). It is now believed that the only native stocks of red deer persisting in Britain and Ireland are in county Kerry, Scotland and northwest England. (Lowe and Gardiner in preparation).

However, in these regions the threat of hybridisation with sika deer is present. Red x Sika deer hybrids have been identified and shot in the north Lancashire area and an effort is being made to segregate the red deer and hybrid deer in areas of sympatry. However, although red and sika deer hybrids have not yet been observed in county Kerry, there is no room for complacency, for even if the county Kerry red deer are reproductively isolated by physiological or behavioural factors from the sika deer, with whom they share the range, hybridisation could easily commence if, for instance, a red x sika deer hybrid were introduced from Wicklow. It has already been reported to this author that Wicklow hybrid calves have been transported to other areas in Ireland and it is quite possible that one could find its way to county Kerry and hence remove the apparent barrier that has, as yet, inhibited the hybridisation of red deer and sika deer.

In areas where red deer are a taxonomic entity and worthy of conservation, it is logical to consider the removal of all sika deer and all red x sika deer hybrids. Many may consider this an inordinately difficult task in county Kerry. In that case, the author believes that the minimum compromise would be the removal of some county Kerry red deer to a sanctuary area which would be free from any threat of genetic contamination with other members of the genus *Cervus*.

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