MANAGEMENT OF THE BARN OWL (*Tyto alba javanica*) AS A PREDATOR OF RATS IN OIL PALM (*Elaeis quineensis*) PLANTATIONS IN MALAYSIA

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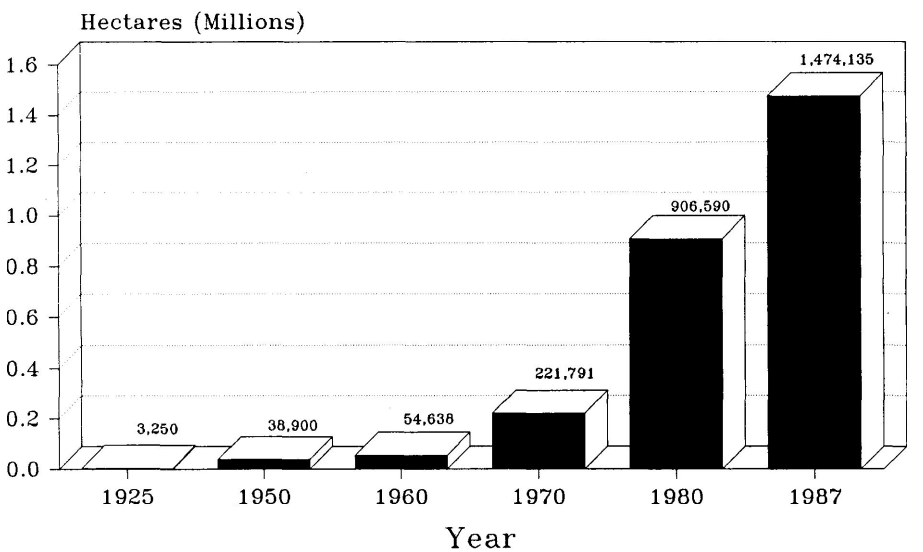
BACKGROUND

Whilst the Oil Palm had been a minor plantation crop in Peninsular Malaysia since the 1920s it was only in the 1960s that really rapid expansion began as can be seen from Figure 1.

Figure 1. Hectares Planted to Oil Palms in Peninsular Malaysia.



Sources
1925 & 1950 : Dept of Agr
1960 - 1987 : PORLA

This rapid expansion as a plantation crop over a period of 30 years has made Malaysia the world's largest producer of palm oil, and the Oil Palm the largest agricultural contributor to the country's economy.

Such an expansion of an alien crop (as its botanical name suggests it is a native of West Africa) is made even more unnatural when one realises that it is planted in Malaysia as a monocrop at around 136 palms per hectare, whilst in its natural state in Africa it is only one of many species co-existing in a mixed tropical forest environment (Hartley 1967).

Thus Oil Palms have become a significant major monocrop environment in Peninsular Malaysia, where they make up 11.2% of the total 13,151,000 hectares land area of the country.

To this completely unnatural environment have come naturally many species of animals and insects which have adapted rapidly. Many have been beneficial or innocuous but others have developed as pests. Amongst the latter, one of the most prevalent and successful has been the rat. Several species of local rats have found the Oil Palm an ideal environment as in the one tree can be found a nest site and a year-round food supply in the fruit. Control of rats in plantations has thus become a continual and costly operation utilising poison baits.

A very interesting corollary to this adaptation of the rat to the oil palm environment has been the appearance and rapid spread of the Barn Owl (*Tyto alba javanica*) throughout Peninsular Malaysia as a predator of the rat. Almost a case-book example of nature abhorring a vacuum and filling a biological niche.

Barn Owls had been reported as casual visitors to Peninsular Malaysia from Java or Sumatra since the late 1800s, but the first ever recorded nesting was in 1969 in the attic of the writer's house, on an Oil Palm estate in Johore (Wells 1972), since when this species has achieved a status change from "very rare" to "common". This rapid spread is most definitely associated with the spread of oil palm as a crop and would not have occurred without it (Lenton 1984).

The occurrence and spread of the Barn Owl was watched with great interest by many concerned with rat control in the plantations and whilst the geographical spread was excellent it was noted that population density was sparse and at levels that could have no significant effect. This was rather surprising as the food-prey populations were very large and, if unbaited, levelled off at populations of around 250 - 400 rats per hectare (Wood 1978).

Early investigations indicated that population densities were limited by available nest sites (Duckett 1976) and that many adult birds in estate populations were not breeding because of this lack of nest sites. This was confirmed during 1976-78, when Graham Lenton spent two and a half years

on his PhD. study (Lenton 1980) working under Dr. Wells of University of Malaya, in which he proved several very important points:

a) That artificial nest boxes designed by him were accepted by Barn Owls.

b) That Barn Owls were not territorial in hunting areas and would happily co-exist in close proximity.

c) That population densities increased with increases in available nest sites.

d) That rat baits using Warfarin as the active poison ingredient had no apparent ill-effects on Barn Owls via secondary ingestion, although this was not the case for some of the mammaliam predators.

e) That the diet of Barn Owls in the oil palm environment consisted of 98% rats.

The general findings of research at this stage, mainly based on Lenton's work, were summarised at the International Oil Palm Conference held in Kuala Lumpur in 1980 (Duckett 1981), which encouraged the setting up of several small-scale trials by private sector companies.

The Barn Owl projects received some setbacks in the early 1980s when "second generation" poisons, developed after the discovery of "Warfarin resistance" in rats in Europe, were introduced to Malaysia. These poisons, anti-coagulants like Warfarin, were highly effective in poisoning rats but were far more toxic and had serious effects on non-target species, amongst which significantly was the Barn Owl. Secondary poisoning took place via the ingestion of rats that had recently eaten these poisons and Barn Owls were wiped out in many areas where they had established themselves successfully. It was therefore established that if you wished to utilise Barn Owls within an integrated rat control system such "second generation" baits should be avoided (Duckett 1984; Lenton 1984).

In 1985 the Palm Oil Research Institute of Malaysia (PORIM) recognised that Barn Owls could play a significant role in an integrated control of rats in Oil Palms (Basri & Halim 1985) and this was followed by the arrival at PORIM of Dr. Christopher Smal to carry out Barn Owl research.

Dr. Smal started his initial trials in 1986 on two commercial estates in Selangor, on one of which 30 nest boxes had been in existence since 1980. His work in these locations gave good indications that Barn Owls could be constructively utilised in an integrated system where Warfarin-based rat baits were used.

Even more significantly, he found reason to believe that there was a potential for total control by the Barn Owl once owl populations were built

up to adequate levels and rat populations were at that time reduced by Warfarin baiting to a level where an equilibrium could be established.

Dr. Smal's arrival on the scene also provided a stimulus to those private sector estates that had commenced nucleus nest-box schemes and several of these were extended at various locations.

At this stage it was decided that a large scale trial based on commercial size should be established to prove that:-

a) Owl populations could be built up over large areas.

b) That eventually these populations could give complete biological control.

c) That such control could be achieved at lower costs than by the use of baits, which would be a major commercial incentive for the industry to expand such projects.

The PORIM/Austral Enterprises Joint Barn Owl Project at Kok Foh Estate, Bahau, Negeri Sembilan

The above project is a joint approach between PORIM and Austral Enterprises Berhad (AEB), a private sector plantation company, in which the writer is employed.

The area covered by the trial is 1,000 hectares of mature Oil Palms within which 200 nest boxes have been placed at a density of one box to every 5 hectares. The box design is shown in the accompanying illustration and is a refinement by Dr. Smal of the original design utilised by Dr. Lenton in his earlier work (Lenton 1980).

The project was initially supervised on site, under direction of Dr. Smal of PORIM and the writer, by a full-time researcher, Mr. S. Karuppiah, who carries out monthly monitoring of boxes during which young birds are fitted with numbered leg-rings; studies rat populations by cage trapping, marking and release; supervises baiting; and carries out fruit damage censuses. In addition he runs an aviary where captive birds are bred and studies are made of breeding, feeding habits etc. All data are stored on computer. Dr. Smal returned to Ireland in November 1989 and the project supervision has been continued by the writer.

Kok Foh Estate was considered a suitable site for establishment of the trial as we were aware, before commencement, of nucleus Barn Owl populations with breeding pairs in two house attics and several other breeding pairs in old hollow jungle tree stumps that had been left amongst the oil palms. There were also other non-breeding birds seen in the palms, the offspring of the known nest sites, whose own breeding was prevented by lack

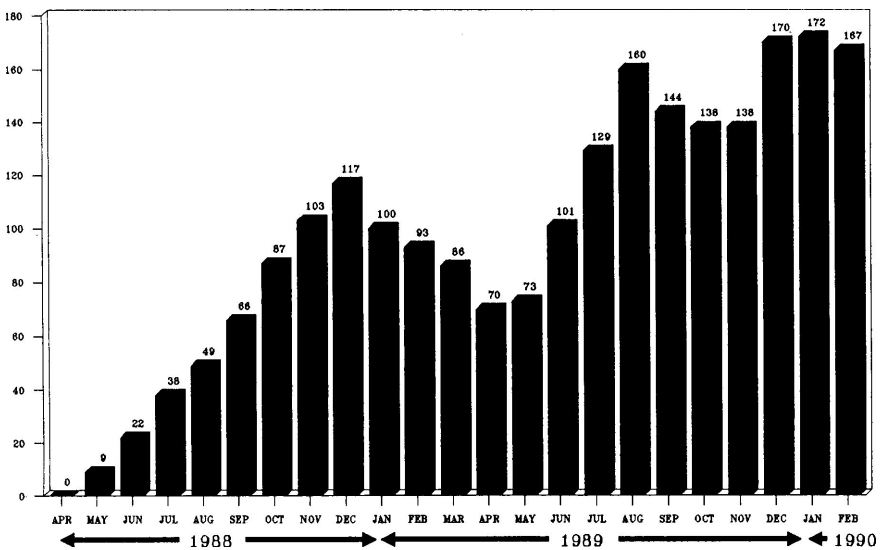
of further nest sites.

Kok Foh also had a history of fairly high rat populations that consistently required full scale baiting rounds to be carried out every six months. The cost of such baiting averaged around Malaysian $20 per hectare per annum.

The rat species on the estate was solely the Malayan Wood Rat (*Rattus tiomanicus*), which is the most common species found in oil palm areas, although the House Rat (*Rattus rattus diardii*) and the Rice field Rat (*Rattus argentiventer*) are found in palms in other locations in Malaysia.

Erection of the 200 nest boxes was completed in 1988 and the subsequent occupancy of these nest boxes by breeding birds is shown in Figure 2.

Figure 2. Occupany of Barn Owls in 205 Nest Boxes in North Division, Kok Foh Estate - April 1988 - February 1990.



Interesting points that arise from Figure 2 are as follows:

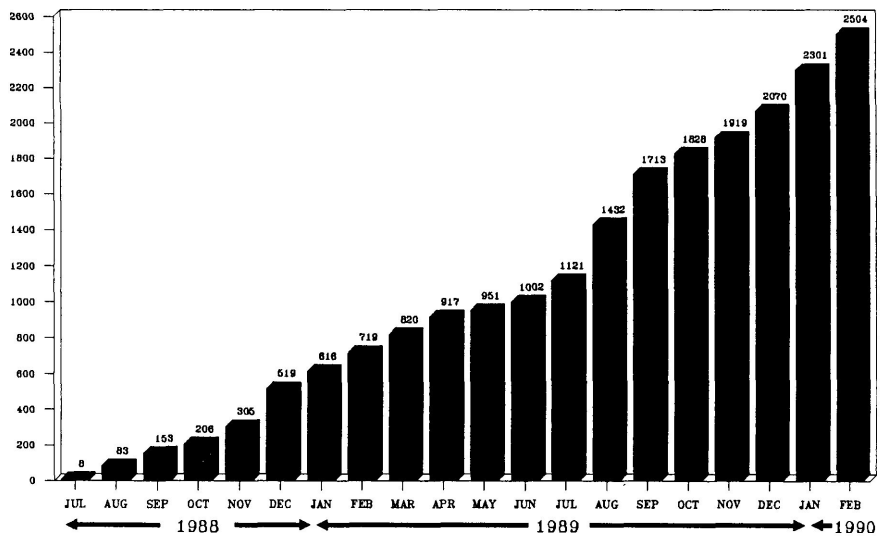
- Whilst two major breeding seasons are recognised during each year (July to September and December to February), breeding does in fact take place throughout the year and since we brought populations up to reasonable levels in December 1988 we have never had less than 70 boxes or 35% utilised by breeding birds in any one month. In fact, since June 1989 we have never had less than 50% occupancy but with rat numbers now greatly reduced we would expect lower breeding levels of owls in the off-peak breeding period of March to June.

- Whilst not evident from the figure, all boxes have been used for breeding but never all at the same time. This indicates that large populations can be *evenly* distributed over large areas by use of artificial nest sites.

- Recording at nest sites has determined that most pairs of parent birds keep returning to the same nest box; most pairs breed twice per year and it is not uncommon for birds to breed and raise three broods in one year when rat levels are relatively high.

- The average number of birds raised from each brood is 4.6. Figure 3 illustrates the cumulative increase of young birds raised in the boxes. All these birds are ringed prior to fledging.

Figure 3. The Cumulative Increase of Young Barn Owls ringed at Nest Sites on Kok Foh Estate July 1988 - February 1990



The above clearly indicates that, with numerous nest sites occupied, Barn Owl production is enormous. If it is realised that the total wild Barn Owl population of the British Isles is currently around 5,000 birds, the 2,500+ birds bred on 1,000 ha of Kok Foh Estate is equivalent to more than 50% of this. It is perfectly safe to say that Kok Foh Estate now has the highest population density of Barn Owls in Malaysia and we would also hazard that it has the highest population density in the world.

Obviously not all the young Barn Owls produced will stay within the area; many will move out. In fact, extra boxes put up outside the trial in South

Division of Kok Foh Estate some seven km away have all been occupied by ringed first-year young birds bred in North Division. Others obviously will move out to neighbouring estates where they will breed if they can find nest sites, and some will obviously travel further afield. We have, in fact, had one recovery recently of a ringed bird from Bengalis Island in Sumatra, some 140 km distant on the other side of the Straits of Malacca, which are around 50 km wide, indicating a considerable non-stop flight capacity in this species.

Thus at this stage we believe that we have fully proven that Barn Owl populations can be built up very quickly over large areas by providing nest boxes in the Malaysian Oil Palm environment, provided that management and supervision is of the adequate calibre.

There had been considerable doubts that this could be done, as earlier attempts, mainly in Europe, had achieved poor success. It is therefore perhaps pertinent to look at the main differences between Barn Owls of the nominate race in U.K. and our tropical bird *Tyto alba javanica.* The main points to consider are as follows:-

1) *Tyto alba* is in origin a bird of the tropics and sub-tropics, spreading outside the warm climates by direct association with man (Voous 1988). In the U.K. it is at the northern geographical limit of its world range and is severely hampered by winter climate, whereby its own breeding and that of its prey items cease during the cold weather (Shawyer 1978). It has been asserted that in Europe three out of four fledged young will die during their first November to February due to lack of food associated with low temperatures and snow cover (Mikkola 1983). In Malaysia, constant warm temperature ensures bounteous year-round food supply and mortality levels of first-year birds are very low.

2) In Malaysia birds raise at least two broods per year and often three (Lenton 1984), whilst in the U.K. one brood, and rarely two, is the norm (Bunn *et al.* 1982).

3) In Malaysia the average surviving brood size is 4.6 (Karuppiah 1989 pers. comm.) whilst in the U.K. it is 3.0 (Shawyer 1987).

4) In Malaysia Barn Owls, because of the abundance of one major prey item, are not territorial and can happily co-exist in very close proximity. In the U.K. shortage of prey items and the need to vary prey items by season mean that generally much larger hunting areas are required and indications are available that territory defence occurs where availability of nest sites and food items are limited (Mikkola 1983).

5) In Malaysia the Oil Palm environment has proven ideal for the Barn Owl, whilst in U.K. changes in farming methods have until recently had the opposite effect, creating a more and more alien environment (Shawyer 1987).

6) In Malaysia Barn Owl populations are normally well away from major roads, which constitute a major hazard and cause of mortality through collision with traffic in Europe (Glue 1973). However, this may become a greater hazard in Malaysia as nest box schemes proliferate.

With the above points in mind it is evident that in potential for population increase the Malaysian Barn Owl has many advantages over its U.K. contemporary, provided nest sites are available.

A census is carried out regularly of fresh rat damage noted on a cross-section of palms in the area and this is graphically illustrated in Figure 4.

Figure 4. Damage trend based on Fresh Rat Damage on 4320 Palms for Kok Foh Trial Area (April 1988 - January 1990)

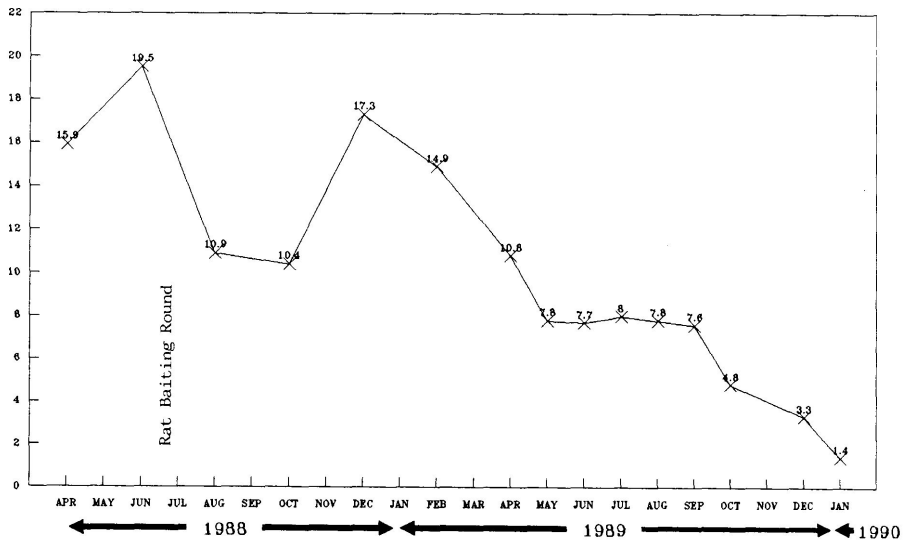


Figure 4 illustrates clearly how with low owl populations fresh rat damage percentages increased from April until June 1988. At this stage, with owl population still low (only 22 boxes occupied), a mild Warfarin baiting round was carried out which resulted in much reduced damage until October 1988, when damage increased until December 1988.

No further baiting was done and from December 1988 damage reduced, which is attributed to the fact that the owl population had built up to a high level (See Figs. 1 & 2 - 117 boxes occupied and 519 young birds already ringed). From May 1989-September 1989 rat damage percentage flattened off and from then on the effect of the very high owl breeding level in July to September 1989 and the maturing of these young birds (with 1,713 young

birds ringed by this date) the rat damage plummeted over the following months until it reached only 1.4% in January 1990, a month in which the highest-ever box occupancy of 172 or 84% is recorded.

Thus the reduction in rat damage has been achieved by Barn Owls with no baiting at all carried out since July 1988, a period of 19 months. Under the previous baiting methods we would have spent pro-rata M$31.66 per hectare over the 1,000 ha or M$31,660. The saving of expenditure of this sum can be directly attributed to the effect of the Barn Owls and their biological control of the rats.

It must of course be realised that in the early stages of the trial we did accept a higher level of damage that would normally have been acceptable whilst owl populations built up and in fairness, if this could be quantified, it should be offset against the M$31,660 not spent on baits. However, it was agreed to accept such losses so as to determine the effectiveness of the Barn Owl.

Those interested in setting up similar biological control schemes must of course realise that they will always have a minor degree of rat damage to fruit bunches as there must always be a certain level of rat population to provide the food source for the owls. If you eliminate the rats your owl population will also leave the area and the whole key is to maintain an equilibrium between rat and owl populations.

The above comments, however, do indicate that the first two aims of the project have been successful, firstly that owl populations can be quickly built up by the use of nest boxes and secondly that rat populations can be reduced to levels where rat damage is insignificant.

Thus, with the first two aims of the project already met, the final aim is to prove that such biological control is cheaper than conventional baiting. This can be shown by comparing the per hectare cost as follows -

- **Rat baiting**

  Various authorities have published on this subject and it has been agreed that a reasonable average cost of baiting has been, as at Kok Foh prior to the owls, M$20 per hectare per annum (Basri & Halmin 1985). There are of course some estates where rat population is minimal and damage non-existent - an interesting situation that could benefit from further study - but there are others where costs of M$40 or higher have been recorded, but as a general average M$20 per hectare would appear reasonable.

- **Barn owl control**

  Whilst one box to 5 ha as at Kok Foh may be a little too dense (Dr. Smal has come to the conclusion after carrying out computer modelling that

one box to 8 - 10 ha may be the best commercial density where Warfarin baiting is used initially to assist in bringing rat populations down to manageable levels for the owls (Smal 1990)) we will use this density for comparison.

Cost of the box with the tall pole, its erection etc., ranges from M$150* and we know it can last for 10 years with around M$5 per year maintenance fee (boxes set up by Graham Lenton of University Malaya in the mid-1970s are still in use in Selangor).

Taking the higher cost of M$150 and 10 years maintenance at M$5 per annum we arrive at a total sum of M$200 for the 10-year period, i.e. M$20 per annum. When this M$20 per annum is divided by the 5 ha we arrive at an annual cost of M$4 per hectare. Thus at this density (one box per 5 ha) we arrive at an annual cost that is only 20% of that of baiting. If the density can be reduced to one box for 10 ha, then this cost is further halved.

Certainly the comparison appears to show great financial advantages with regard to biological control. An added advantage that at this stage is based only on observation is of interest. When we started the project at Kok Foh we saw no other signs of predatory wild life i.e. civet cats, leopard cats, feral domestic cats, when we went round the palms at night, which was not surprising as even Warfarin-based baits killed these mammalian predators. Now, with the last baiting round carried out in July 1988, we see a great number of these other predators of rats within the estate on every nightly round.

It is therefore extremely satisfying to think that by the policy of elimination of baits and of enhancement of the Barn Owl population we have also enhanced the populations of other complementary predators, which all play their part in rat control in the area.

Whilst the overall success appears to be very encouraging, the trial will have to be continued for an extended period in order to ensure that the owl/rat equilibrium can be maintained and that population cycling does not take place. In order to achieve this we may reduce the density of boxes somewhat, based on findings in other trial areas that we set up.

However, we believe that the efficiency and financial viability of the Barn Owl as a rat control agent has been proven and any future problem can be overcome by manipulation of the population by increasing or decreasing the density of the nest boxes.

To be able to achieve such objectives by working with nature, rather than

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* Exchange rates on 5th May 1990 M$4.47 = UK1.00 pounds
M$2.72 = US$1.00.

against it, is unusual in this day and age in agriculture but should remain a desirable target wherever this is possible. For such schemes to have quantifiable commercial advantages is a major factor in ensuring their support and success.

ACKNOWLEDGEMENTS

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APPENDIX

Notes on the Barn Owl Nest Box

The basic design is given in the accompanying figure. Major points to note are as follows:-

1) The box as shown is suitable for situations where it will be in shade of the tree canopy. For exposed non-shaded conditions in the tropics some roof insulation and further ventilation appear necessary to avoid losses from heat in broods. Work is in progress on a suitable design for open locations.

2) The box is constructed of weatherproof plywood (6mm thickness is acceptable but 12mm ply will last considerably longer).

3) The roof is of flat zinc sheet (28 gauge).

4) There is a door for inspection and cleaning at one end with tyre rubber used for hinges.

5) The entrance for the owls is on the long side of the box measuring 20cm in height by 19cm width.

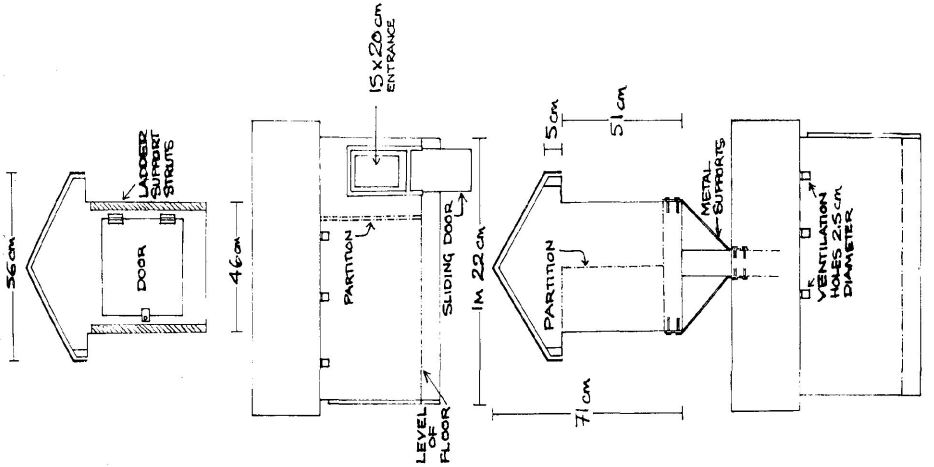
6) A partition, half the width of the box and on the same side as the entrance door, is placed as indicated. This separates the entrance from the nesting section, prevents chicks from falling out and helps to darken the nest area.

7) The supporting pole should be minimum 10cm x 10cm hardwood (although any other suitable material could be used) and should be placed so that at least 1.2m is below ground and at least 4.5m above ground. As the box is heavy it must be well supported in the ground and we prepare a hole with a tractor-mounted auger 0.5m to 0.6m diameter, place the pole centrally, fill with rubble, then pour in a cement mix.

8) When the cement is set the box is affixed to the top of the pole. Two mild steel bars are used as struts to provide additional support.

9) A metal cowl is affixed to the pole to prevent possible predators such as snakes or monitor lizards from gaining access.

SKETCH DRAWINGS OF BARN OWL NEST BOX (after Smal)



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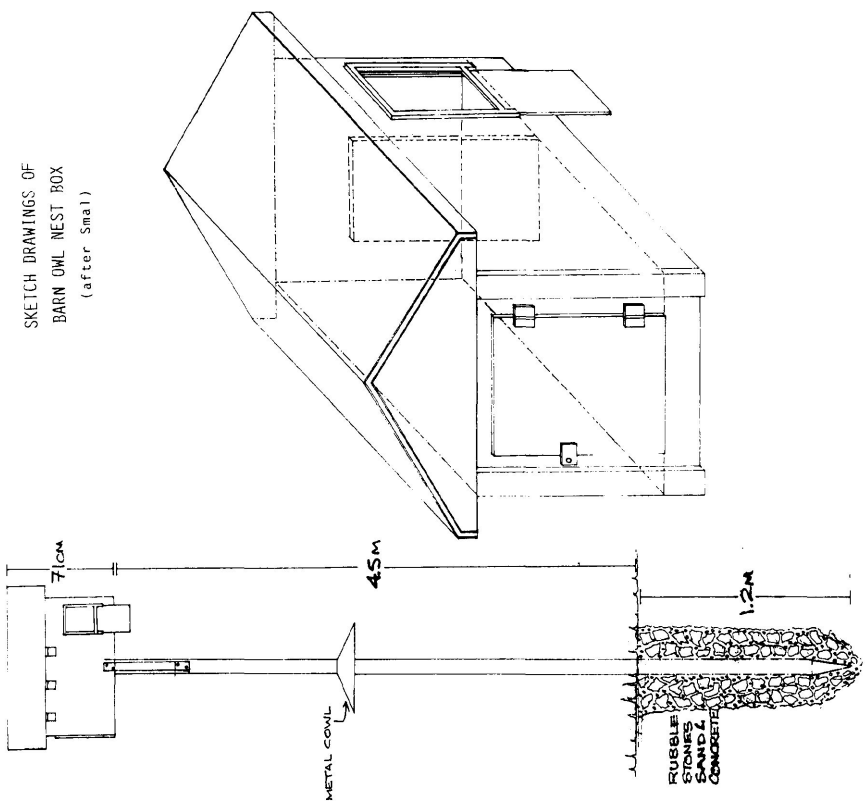

Egyptian Vulture *Neophron percnopterus,* Extremadura, Spain, 23 April 1979. Photo: B.-U. Meyburg