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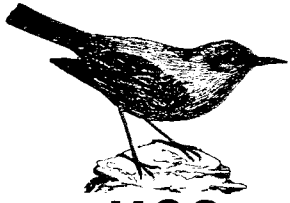

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The Editorial Board welcomes contributions treating any aspect of the Ornithology of the Maltese Islands and the Mediterranean for publication in this Bulletin.

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NOTES ON THE BREEDING BIOLOGY OF THE CORY' S SHEARWATER IN THE MALTESE ISLANDS

RICHARD CACHIA ZAMMIT & JOHN BORG

The Cory's Shearwater *Calonectris diomedea*, is a common breeding visitor to the Maltese islands, nesting along suitable sea cliffs in Malta and Gozo, and on Filfla. The colony on Filfla breeds in cavities in boulder and rubble slopes, while other colonies are situated mainly along the south and south-western coasts of the islands in sheer cliff faces (Sultana & Gauci 1982). Due to their position it is very difficult to observe the birds at their nesting sites. However, a few accessible nesting areas can be reached in some of the colonies, and the following work was carried out in 16 such localities during the years 1983-1986. These sites vary from single accessible nests situated on the upper parts of cliffs, to whole ledges situated on cliff faces. Along these ledges there is a combination of boulders, crevices, caves and vegetated parts. Each area may hold from 1 to 10 accessible nests as well as other breeding pairs which nest in deeper crevices, making their observations impossible. Altogether an average of about 46 nests were under observation annually.

Method

Observations were carried out regularly (3 times weekly, on average), mainly at night, commencing from the last week of February up to the last week of October, thus covering the whole breeding period. Birds were ringed either as they entered the colonies, or on the nest in the case of accessible ones. All such nests were numbered in the first year of the study period and a record of the breeding success of each nest was kept in consecutive years. The adult birds of most accessible nests were paired each year to investigate whether any displacement in adult birds occurs. Birds were sexed according to bill's lenght, using the methodology of Ristow & Wink (1980). Pairing was carried out during the incubation period, as it was found out that nests may be occupied at other times by different birds which could be prospective breeders. In 1986, three nests at different sites were under daily observation during incubation. The sample number is low due to various reasons, including constant human activities near colonies as well as the difficulty of visiting the nest daily.

Breeding Sites

The south-western coastline of Malta consists mainly of continuous cliffs stretching for about 25km, while almost 12km of cliffs make up the south-western coast of Gozo. In most areas the cliffs are 'honey-combed' with caves, crags, fissures and ledges situated at various heights and offering ideal nesting sites for shearwaters. In such areas the cliff ledges tend to be vegetated. Few plant species are to be found, but usually these grow into considerable clumps and bushes. *Darniella melitensis* is the dominating plant, growing in thick bushes, while *Centaurea crassifolia* grows in large clumps in some areas. *Capparis spinosa* is also well distributed. In some places large boulders and debris have collected beneath cliffs as well as on cliff ledges, increasing the availability of nesting sites. On the other hand, some cliff faces are very smooth, devoid of crevices or ledges and with little, if any, vegetation.

While in Crete nests are scattered throughout gently sloping areas and around the top of the less sheer parts of the cliff (Round & Swann 1976), most Cory's Shearwaters in the Maltese islands nest along vertical cliffs. The majority use natural holes and crevices as nesting sites (see Table 1), breeding in every suitable place, from large caves to single small holes and from sea-level up to 130m. This was also the case for nests found on islands in the Marseille area, where 60% of those examined were in natural crevices (Fernandez 1985). Birds nesting in natural holes as well as under boulders and slabs are also found in Crete (Round & Swann 1976). Cory's Shearwaters breed amongst boulders as readily as they would in natural holes or crevices. On Filfla almost all breeding pairs are to be found nesting beneath boulders and the tons of debris which cover its sloped base (Sultana & Gauci 1970). The only reason why nests amongst boulders figure less prominantly than

those in natural holes (Table 1), is because adequate areas with boulders are limited throughout the colonies on the main islands.

TABLE 1 : Nesting sites used

Year	Sample number	Percentage from sample			
		Natural holes	Amongst boulders	Beneath vegetation	Self excavated
1983	41	68	15	5	12
1984	36	55.5	25	8.5	11
1985	52	58	29	2	11
1986	55	51	26	5	11
Mean %		58	26	5	11

On Great Salvage in the Atlantic, where *C.d. borealis* breeds, any crevice or hole of sufficient size can shelter a nest. Ruined human habitations are also used, while on the plateau the shearwaters themselves sometimes excavate actual burrows in the soft earth (Roux & Jouanin 1968), while some have also been noted to use rabbit holes (Jones 1986). From the nests examined in the Marseille area, 29% were found in self-excavated holes and 5% in rabbit burrows (Fernandez 1985), while in Crete no self-excavated burrows were noted (Round & Swann 1976). In the Maltese islands, self-excavated burrows are necessarily few due to the rocky terrain where the Cory's Shearwaters breed (see Table 1). Rabbits *Oryctolagus cuniculus* which are fairly common along the cliffs, rarely dig burrows for the same reason. Most self-excavated burrows found are merely depressions dug beneath boulders or stones. Only two actual burrows have been found and these were excavated in the soft earth produced by the weathering of the rocks and which sometimes accumulates on cliff ledges in appreciable amounts. On Filfla only one self-excavated burrow was located and this was in weathered clay (Sultana & Gauci 1970). No nests have been found in rabbit burrows.

A good proportion of the large colony found on Linosa, in the Sicilian Channel, nests beneath scrub which covers a large part of the breeding area. There, birds nest amongst rock and deep in holes covered by the plants, but a good number use only the dense vegetation as a nesting site (Massa, pers. comm.). In the Marseille area, nests under vegetation figured least (3%) and this is also the case for those found in the Maltese Islands (Table 1). This is rather peculiar, as many areas with thick vegetation are available, especially on cliff ledges. The few birds found nesting under vegetation had their nests deep inside clumps of bushes. Such nests are few because they are more vulnerable to human interference and to predation, especially from rats *Rattus sp.* which are common in cliff areas. However, the few known nests beneath vegetation were always successful during the study period. One pair was found nesting in the shade of a small bush, very much exposed. After breeding successfully in 1983, the nest was abandoned the year after due to human disturbance.

Some nests on Linosa were at least 10m underground (Vaughan 1980). In the Marseille area, Fernandez (1985) found an incubating bird 12.5m deep in a narrow crevice. On Great Salvage any crevice and hole of sufficient size can shelter a nest. Sometimes the hole is large enough for the sun to penetrate or for several pairs to take up their abode (Roux & Jouanin 1968).

In the Maltese Islands, incubating birds were found from a few centimetres inside burrows/crevices - exposed to daylight - up to 8.5 m in constant darkness. Other birds were breeding even deeper, in burrows/crevices whose depth could not be estimated. On Filfla, Sultana & Gauci (1970) found some incubating birds barely 30cm from the entrance, exposed to daylight, while others were as deep as 4 m. One pair laid the egg only 20cm from the entrance of a small hole in a vertical cliff face. This nest was used only once during the study period as the egg failed to hatch and was later abandoned.

Some sites have communial entrances. In one area, up to six pairs were noted entering a small hole which led into different chambers. In some areas, a few nests were in close proximity of each other. At two colonies in Gozo, birds were seen sharing the same entrance with Manx Shearwaters *Puffinus puffinus*. Suliana & Gauci (1970) found them breeding close to Storm Petrels *Hydrobates pelagicus* on Filfla.

Nest Structure

No actual nest is built, but many Cory's Shearwaters use various articles to 'decorate' the nest. Most lay the egg on the bare soft earth. Feathers have been noted in nests

mainly at the time of egg laying and are probably produced by the formation of the brood patch of the incubating birds. Plant matter is sometimes also used. On the Great Salvage they frequently decorate the nest with pebbles, shells, bones or vegetable debris (Roux & Jouanin 1968). In Malta a spent shot-gun cartridge was found at one site. This was in a nest 3m deep. In places where small stones are to be found, these are placed at the fringes of the nest, close to each other. This behaviour was also noted on Linosa (pers. obs.). The North Atlantic subspecies *C.d. borealis* was found by Lockley (1942) to make flat nests of small stones in the Berlenga islands off the Portugese coast. In the Great Salvage it was noted that when the ground slopes steeply, the building of a platform of pebbles assures a horizontal surface for incubation (Jouanin & Roux 1966). It is not entirely necessary that the shearwaters use stones only to make a horizontal surface, as both in Malta and on Linosa the ground where nests with stones were located was sufficiently flat. In Malta, it was noted that nests which were found on soft ground had a sort of depression. This is done by the continuous scraping of the incubating bird, prior to and after egg laying, and in consequence a mound is formed at the entrance of the nest. This mound gives the impression that no nest is in evidence. At times this mound, coupled with the depression, can rise up to an appreciable height. Where these mounds/depressions occur, it is sometimes almost impossible to see the incubating bird and later in the breeding season it is impossible to see the chick until it reaches a certain age.

Fidelity to site and mate

Many seabirds are faithful to the same site and mate in successive breeding attempts (Nelson 1980). Wink, Wink & Ristow (1982) have shown by means of ringing that a high degree of site tenacity and pair bonding exists also amongst Cory's Shearwaters. One bird was found to have nested in its burrow for 11 seasons and 3 birds for at least 6 years, while one pair stayed together for at least 6 years.

In Table 2, the sample number reflects the number of nests in which both breeding birds were known in year (X) as well as in the following year (X+1). Nests, where only one of the partners was known during any one of the years taken in consideration, are not included. For example, in 1983, 49 incubating birds were marked from 30 nests. This left 11 unmarked birds, which correspond to 11 nests where only one of the pair was known and so these could not be taken in consideration when calculating fidelity to mate. However the next year, out of the 19 remaining nests, one was not paired. This leaves a sample of 18 nests which can be analysed. These include also nests which were found abandoned in the following years.

TABLE 2 : Fidelity to site and mate

Year (X)	No. in sample	Per cent of sample in year (X+1), in which					
		♂& ♀ return to same site	♂ returns ♀disappears	♂disappears ♀returns	♂ disappears ♀ moves	♂moves ♀disappears	♂& ♀ disapp.
1983	18	78	5.5	-	-	5.5	11
1984	24	71	13	4	-	4	8
1985	23	65	13	9	4	-	9

The mean percentage of the sample in which both adults returned to the same site is 71%. In most cases there was no evidence of incompatibility between pairs of which one of the birds was substituted in the following years. So it would seem that the changing of a partner was mainly due to death. In the majority of cases the remaining bird managed to find another partner and bred in the same nest while in a few instances the remaining bird moved to another nest in the vicinity. At one study area in 1983, two pairs (pair A: Male-FF00347, Female FF00302 and pair B: Male FF00263, Female FF00262) bred successfully in natural crevices about 1.5m from each other. In 1984, the same pairs were again breeding at the same sites. However during incubation, pair A was disturbed while pair B bred successfully again. In 1985 only the male of pair A (FF00347) turned up at its nesting site while only the female of pair B (FF00262) was retrapped, also in its corresponding nesting site. The male of pair A continued to visit the site up to the beginning of May. On visiting the area during incubation, the nest of pair A was found empty, while the pair breeding in the nest of pair B was made up of the original female of pair B (FF00262) and the male of pair A (FF00347) and they bred successfully in that year as well as in 1986.

Egg laying

Sultana & Gauci (1982) give the laying period as being from mid-May to mid-June. However, during the four-year study period carried out by the present writers, no eggs were found laid before 24 May and none after 1 June. Sultana & Gauci (1970) found an incubating bird at Filfla on 18 May 1969, but this could have been an exception. Egg laying in shearwater colonies is highly synchronized and all were found to lay in the last week of May, with peak days on 27-28 May.

Incubation

During 1986, the incubation period of 3 pairs at different areas was recorded daily, except for one day each. In all three cases, the male took over the first incubation spell, immediately during the first night after egg laying. This was also evident in other nests. The immediate taking over by the male for the first incubation spell had been noted by Zino (1971) on the Salvage Islands, where in the majority of cases (88% of sample), the male was found incubating within 24 hours of laying.

The incubation period for the three above mentioned nests was of 52 days each, laying day inclusive. There was no appreciable difference between the total duration of incubation by males and that by females (see Table 3). Zino (1971) gives a mean 53.8 days for the incubation period of the Cory's Shearwater on the Salvage Islands.

TABLE 3 : Analysis of 3 nests during incubation

	MALE	FEMALE	NEST NOT VISITED	TOTAL
Pair 1	30 days	21 days	1 day	52 days
Pair 2	23 days	28 days	1 day	52 days
Pair 3	21 days	30 days	1 day	52 days
Mean	24.7 days	26.3 days		52 days

Wink *et al.* (1982) give the average incubation spells of birds in the Aegean as 8.1 days for males and 9.2 days for females, and Zino (1971) gives an average of 6 days for both sexes from the Salvage Islands. In Malta a total of 31 change-overs was noted amongst the three pairs under daily observation. The incubation spells of males lasted from 1-9 days with a mean of 4.6 and a standard deviation of ± 2.49 days, and for females, from 1-10 days with a mean of 4.4 and a standard deviation of ± 2.27 days. Change-overs were more frequent during the last days of incubation (see Fig. 1).

In 1983 an unexplained occurrence was noted in a particular nest where 3 individual birds were found incubating the same egg. On 11 June a female (FF00344) was found incubating beneath a boulder. Two days later the male (FF00348) was sitting on the egg. However on 27 June a new female (FF00557) was found incubating the same egg. The egg hatched and the young fledged successfully. The male (FF00348) and the second female (FF00557) continued to breed successfully in the same nest for the following three years, while the first female (FF00344) was never seen again until two years later, when it was caught at night entering a deep hole about 7m below the original nest. It was caught again in 1986

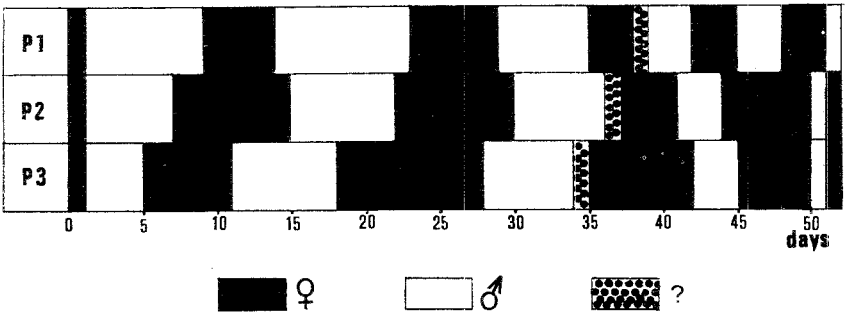

Fig. 1 : Incubation spells of males and females in three pairs.

entering the same hole. Harris (1966a) recounts a similar occurrence on Skokholm Island where three Manx Shearwaters (2 males and a female), were found occupying the same nest in which two eggs were laid. In this case the female might have had different mates for the two eggs laid, whereas in the case of the Cory's Shearwaters there was no evidence that a second egg was laid. On 16 August 1983, a female was found in a nest during the day, still incubating an egg which never hatched.

Feeding of young birds

Vaughan (1980) gave a detailed account of the feeding of young birds by parents. While on a visit to Linosa, he observed that the actual feeding is a lenghty affair. At first, the adult spends most of the time just sitting by the chick inactively. During the feed, the chick starts to point its bill towards the adult, later developing into a violent, almost frenzied motion of pecking and nibbling at the parent's head and bill. These pecks take the form of a rhythmical thrusting to and fro and the chick appears to become frantic. The adult responds in a similar behaviour followed by the opening of the bill, when the chick thrusts its bill inside it, getting more or less liquid rather than solid regurgitations. After the feed, both birds' beaks open and close rapidly for a short time. During the entire feed, the chick keeps calling, with the cries rising to a crescendo during the actual feed. This operation takes a minute or so and is followed by a pause. It is then repeated several times. The whole feed occupies 15-20 minutes. When it is over the chick subsides into inactivity and falls asleep. Similar behaviour was observed by the authors, at colonies in the Maltese Islands.

Vaughan (1980) also questions the possibility that this feeding method may change as the young bird grows, until fledging time, as he quotes observations carried out by Bannerman & Vella-Gaffiero (1976), who stated that in a colony in Malta, they found 4 young Horse-Mackerel *Trachurus trachurus* "fresh enough to have been taken the night before and still untouched by the young". Sultana & Gauci (1982), regard these observations as puzzling and misleading, as they found out that regurgitated food is given up to the time when the adults cease feeding their young. Observations carried out by the authors also confirm this as this method of feeding was noted up to a few days before fledging. Bannerman & Vella-Gaffiero (1976) mention young mullets *Mugil sp.*, as food given to chicks. This is also puzzling as from a number of regurgitations analysed by the authors the contents included Squid *Loligo vulgaris*, Anchovies *Engraulis encrasicolus*, Flying-fish *Cypselunus rondeleti* and Horse-Mackerel, but no sign of *Mugil sp.* Sara (1983), also mentions Eels *Lepidopus caudatus* and young sharks up to 15cm long, as taken by this shearwater, along with other species of fish. He also found no *Mugil sp.* in the regurgitations he analysed. All *Mugil* species are to be found in shallow waters and close to shore (Lythgoe & Lythgoe 1971) and Cory's Shearwaters have always been observed feeding out at sea at least 3-4km offshore.

Breeding Success

On the Great Salvage, Zino (1971) found that 30 out of 42 eggs hatched, i.e.(71% of the eggs laid). 17% of the eggs laid were taken by Yellow-legged Gulls *Larus cachinnans* which constantly patrols the breeding areas and take the exposed unattended eggs.

In the study areas in the Maltese Islands, the mean hatching success was 80%. Although a few pairs of Yellow-legged Gulls *Larus cachinnans* still breed along the cliffs of Malta and Gozo, no predation of eggs was noted to have taken place by these gulls. Most unhatched eggs were found abandoned and on examination were found to be addled. In 3 cases the eggs, which were found broken, were sticking firmly to the underside of the incubating birds. In some cases, pairs which had bred successfully together in previous years

TABLE 4 : Breeding success

Year	Sample no.	Percentage per year		
		Unhatched eggs	Unfledged pulli	Successful fledging
1983	41	27	5	68
1984	36	8.5	8.5	83
1985	52	23	8	69
1986	55	22	9	69
Mean	46	20	8	72

failed to hatch the egg in a particular year. Usually this coincided with the total disappearance of one of the birds, probably due to death. Most of the chicks which did not fledge, died in the first two weeks after hatching. At this time they are still quite small and relatively weak, and can be preyed upon by rats. In 1986, in one study area all five known chicks were found dead or missing at the same time. One of the nests was in a narrow natural crevice and although the chick could not be seen or reached by humans, it was found dead at the crevice's entrance. This could have been the work of a Ferret *Putorius putorius furo* which is still used by a few people for hunting rabbits. In some cases the chick died later in the breeding season but again this was often the result of the disappearance of one of the adults.

Survival of Adults

In 1983, 49 incubating birds were ringed on the nest at different study areas. Many were retrapped in the following years while at the same time other breeding birds were ringed. Each year a constant effort to pair breeding birds was made with frequent visits to the study areas during the incubation period, and very few birds were missed. Still the figures in Table 5 can be considered as minimal as there is always the possibility that some birds may have been alive elsewhere.

TABLE 5 : Adult Survival of Cory's Shearwaters between 1983 and 1986

Year (X)	Breeding birds marked in year (X)	Breeding birds alive in year (X+1)	% Survival
1983	49	41	83.7
1984	65	54	83.1
1985	63	45	71.4

The mean survival turns out to be 79.4% which is very low for a sea-bird. Wink *et al.* (1982) carried out a similar study on Cory's Shearwaters in the Aegean between 1977 and 1980, also covering a period of four years. The survival for the first year was 87%, for the second 85% and for the third 93% giving an average survival of about 88.3%, approximately 9% higher than that for the Maltese Islands. Adult survival has been studied in many other Procellariiformes, all of which gave a survival rate of 89% or over (Nelson 1980). The reason why the survival of adult Cory's Shearwaters in the Maltese Islands is so low can be attributed to direct human persecution. One has to consider that this study is based on somewhat accessible areas of colonies, and though difficult as it might be, some persons, especially fishing enthusiasts manage to descend to these areas. During all four years of the study, several birds were found killed in such areas and many nests were found disturbed. Some fishermen still kill the birds to take some feathers from the underwing to use as fishing tackle, while considerable numbers of shearwaters are shot from sea-crafts for fun. Sultana & Gauci (1982) remark that the numbers shot every summer must be considerably high. Indeed when one considers that shooters do not kill only adults but shoot at random, killing also non-breeders, and considering that in a colony these non-breeders are usually by far more numerous than the breeding birds (Araujo *et al.* 1976), the number killed by locals has to be extremely high.

Return to colonies of young birds

In his work on the Manx Shearwater, Harris (1966b) remarks that most shearwaters tend to return to their natal colonies, and also that young birds are even faithful to their natal areas within the colonies. The Cory's Shearwater follows the same trend (Jouanin, Roux & Zino 1977). From 1968 up to 1982, seven pulli ringed on Filfla were retrapped there in later years (Sultana & Gauci 1982). Two more have been retrapped in recent years (MOS-Bird-ringing records). Three other pulli have been retrapped from their natal colonies in Malta, one of which was erroneously reported by Sultana & Gauci (1982) as being retrapped after one year, when in fact it should have been two years. Most were retrapped in their 6th and 7th year. This does not necessarily mean that this was the first year that they returned to their natal colonies as both Filfla and the colony in Malta were covered sporadically with an average of only 2-3 yearly visits. All, except one, were caught as they were entering the colonies at night and it was not noted if there was any evidence of breeding or not. However, a bird ringed as a pullus and retrapped after four years, was found incubating. The egg hatched and the young fledged successfully. This is probably the youngest breeding Cory's Shearwater known.

TABLE 6 : Birds ringed as pulli and retrapped in later years

1	2	3	4	5	6	7	8	9	Years
-	1	-	1	1	4	3	1	1	No.

Non-breeders

Vaughan (1980) records large numbers of non-breeders present each night in the colony on the island of Linosa during the time he was there (8-16 Aug. 1978). Massa & Lo Valvo (1986) calculate the population of non-breeders for the same colony as being about 50% of the adults. Wink *et al.* (1982) also noted in the Aegean, that during the incubation period as well as during the first week after the chicks hatch, one can regularly see that there were up to 50% more shearwaters in the test area than there were existing breeding pairs. It was supposed that the majority were non-breeders. The number of non-breeders visiting the Cabrera Archipelago in summer was even higher as it was estimated as being approximately three times the number of breeding adults (Araujo *et al.* 1976). On the other hand Round & Swann (1976) did not identify any non-breeders in the vicinity of the colony they studied in Crete from 17 Jul-4 Aug and from 27 Aug-24 Oct 1974. In the Maltese Islands, non-breeders can be found in the colonies almost throughout the whole breeding season, though numbers have never been estimated. They are less evident as the breeding season approaches the end. The latest date was of a bird ringed on 14 October 1985. The bird's bleached plumage excluded the possibility of it being a fully plumaged fledgling, while its behaviour was that of a non-breeder.

The behaviour of these birds in a colony varies a lot, presumably according to their age as they approach breeding maturity. Some can be found sitting at the entrance of nest holes, without venturing to enter. Vaughan (1980) also noted this on Linosa. Very often when approached these birds would rather find another way of escape rather than entering the nest holes, quite unlike the breeding birds which are very quick to do this. This behaviour was also noted with Manx Shearwaters on Skokholm (Harris 1966b). If forced to enter the nest hole they are usually quickly chased out by the occupant of the nest. Other non-breeders land in areas where there are no nests at all and just sit amongst vegetation looking quite lost, while others already show a high degree of breeding behaviour. Very often they return at night to the same area where they occupy a make-shift nest, usually being just a shallow excavation beneath a rock or a very small crevice, too small for actual breeding. Frequently these birds are very faithful to these areas not only during the year of ringing, but also in successive years and this is to be expected as many would be young birds returning to their natal colonies (see Return to colonies of young birds). Some would eventually end up breeding there, occupying suitable vacant nest holes, replacing missing birds or starting a new nest. This was very evident in extensively worked areas where weekly visits were made during most of the breeding season. In such areas vacant nests or missing partners were replaced by birds of unknown age, which had been ringed and consequently retrapped from the same area even up to two years before and which had been judged from their behaviour to be non-breeders.

Some non-breeders are known to form pairs. Paired non-breeders may be found courting in totally unsuitable areas, and these, as described by Fisher & Lockley (1954), are only playing at 'house keeping'. Harris (1966b) wrote that it is not known if immature Manx Shearwaters will retain the same partner until old enough to breed. He also questions the possibility that non-breeding birds of unknown age which remained paired, were actually birds which had bred previously and for some reason were not breeding in the year when they were found. Some Cory's Shearwaters of unknown age, ringed one or two years before from a given area, were retrapped during various nights in different parts of this area, indicating that they were not established breeders. Eventually suitable nesting sites were found and these birds, irrespective of sex, started to try to lure a mate by sitting at the entrance of the nest hole and calling. This is also done by established breeders when their partner turns up missing. When a mate was found these birds visited the place frequently at night and more often than not, they were found courting even though it was too late to breed. However, the following year most pairs were found breeding. These could have been mature birds ready to breed but were hindered from doing so by the lack of a suitable breeding site. Nelson (1980) mentions the importance for shearwaters to spend a pre-breeding period, (in the case of the Cory' Shearwater from March to mid-May), to strengthen pair-bonds by staying for long periods at the nest site. This clearly explains why even though nesting site and mate were established late in the breeding season, yet these birds spend a lot of time courting. This gives the birds an advantage, as in the forth-

coming year they can devote more time to continue to strengthen the pair-bond, which is so important for successful breeding, instead of spending a lot of time and energy to find a mate and build up a pair-bond.

Sometimes paired non-breeders or prospective breeders, may be found courting in nest sites that are known to be occupied by other pairs. This is evident during the pre-breeding period, when the colony is in a somewhat confused state, with new birds trying to establish themselves in the colony or in the case of unpaired, trying to find a mate. Some of these birds which were found courting in established nest sites, were later in the year found breeding in different nest holes and also with different partners.

On 21 March 1985, two birds (Male: FF00706 and female:FF00705) were found courting during the day in a nest hole which had been used successfully by another pair (male: FF00097 and female: FF00560) for at least two years. At night the old male (FF00097) arrived and entered the nest. After a short quarrel, one of the birds flew out of the nest hole. On inspecting the nest, the old male (FF00097) was found to be still there, but the other remaining bird was out of reach, and so it was impossible to determine which bird of the new pair actually left. After that day, only the old pair (FF00097 and FF00560) was found in the nest hole and again they bred successfully. However, the year after, the old pair disappeared completely and their place was taken over by the same new pair (FF00706 and FF00705) which eventually bred there, although without success.

In many procellarids, the cause of noisy skirmishes, is the visiting of occupied burrows by unattached birds, including newcomers to the colony (Nelson 1980). Although short quarrels are quite a frequent event in Cory's Shearwater colonies, especially in the pre-breeding stage, only once was a real fight between two birds witnessed. Arriving at the place of the fight after being attracted by loud screams, two birds entangled together were seen tumbling down the cliff. The fighting birds could still be heard screaming as they dropped down to the sea.

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Richard Cachia Zammit - 20, Oleander Avenue, Sta. Lucia, Malta.
John Borg - Block C2, Flat 5, Housing Estate, Ta'Xbiex, Malta.

IMPROVED DECISION MAKING BY MIGRATING DIURNAL RAPTORS DURING MORE INTENSE MIGRATION

MARTIN A. THAKE

The possibility that decisions made by flocks of animals, including birds, might be the product of a concensus was first stated explicitly by Lorenz (1952), but his comment did not elicit any research effort, although Condorcet (1785 ; see also Grofman *et al.* 1982) had shown that majority decision making should lead to distinct statistical advantages. There is every reason to believe that majority decision making could evolve in natural populations (Thake 1984-1985b).

In this paper, positive correlation is demonstrated between the accuracy of a decision to migrate made by certain raptors, and the total number of raptors on migration at the time.

Methods

The data used in this paper were obtained during visual watches maintained at Buskett during the autumns of 1976-78. For details of the observation methods, the reader is referred to earlier papers (Thake 1977, 1980). Although the period and duration of observations varied slightly from year to year, coverage during September was very uniform, and data for this month alone were used in the calculations.

Details of local weather were recorded at hourly intervals. Additional data were obtained from the records of the meteorological stations at Luqa and Qrendi. Regional weather maps were supplied by the Deutscher Wetterdienst and by the Hellenic National Meteorological Service.

Results

All calculations were performed on a Casio Fx 801P programmable calculator, using *ad hoc* computer programs devised and tested by the present author.

Wind strength data recorded at hourly intervals at Buskett were used to calculate the mean wind strength during a given watch. Watches were scored for suitability of migration conditions on the basis of wind strength alone. 'Good' conditions were considered to have prevailed on days when mean wind strength during a watch was less than 10 knots, while 'Bad' conditions were characterised by a mean wind strength of more than 10 knots. Data for September of each year were tabulated by date, forming the raw data for the analyses which followed.