SYNOPTIC SCALE WEATHER AND HONEY BUZZARD (PERNIS APIVORUS) MIGRATION ACROSS THE CENTRAL MEDITERRANEAN

by Martin Thake

Honey Buzzards regularly make long sea-crossings while on migration across the Central Mediterranean (Ref. 1, 5, 6, 7.) but little is known, however, about the conditions under which these crossings are made and the flight-styles employed.

SOARING

Cross-country soaring is commonly employed by broad-winged raptors migrating overland. Thermals of sufficient strength to be used by such raptors are relatively uncommon over the sea. In September, the Central Mediterranean is still fairly warm. Influxes of cool air (chiefly maritime polar and continental polar) frequently result in conditions of convective instability. There are, however, no reports of Honey Buzzards using cellular convective currents over the sea. There is only one definite reference to Honey Buzzards using the thermals which precede the thunder-storms of cold fronts (*Gibb 1951; Ref. 2*). In this study, only a small minority of the Honey Buzzards were sighted during the passage of a frontal system and a similar proportion was observed by Beaman and Galea (*pers. comm.*). Although in a few cases the birds' behaviour appeared to be opportunistic, in most cases they seemed to be trying to avoid the front. Gibbs' observations of Honey Buzzards that '... accompanied even those storms which were temporarily travelling northwards over Malta ...' in September certainly do not suggest opportunistic behaviour. (*Ref. 2: p. 118*)

There are several reasons why avoidance behaviour would be adaptive. The down-draughts in a thunder-storm often reach 10 m/sec. and are frequently accompanied by very intense precipitation. The very adaptions which allow raptors to utilize rising air-currents make thunder-storms particularly hazardous to members of this order. The use of the thermals ahead of a frontal system, although feasible, is rendered dangerous by the fact that the wind just ahead of the frontal surface has a strong component directed toward it. It would be less risky for raptors to utilize the unstable maritime polar air-streams which usually follow the front. The winds are usually in the north-westerly quadrant (i.e. virtually tail-winds in autumn) and thermals abound. Yet most sightings associated with frontal systems have occurred ahead of the front and the few raptors sighted in this study after the passage of fronts were flying away from them, often against the wind.

On 11/9/76, a large influx of Honey Buzzards was observed during the approach of a cold front from the West. 109 Honey Buzzards were sighted, mostly between 14.00 and 17.00 hrs. CET. All the birds sighted remained in the general vicinity of the wooded valley of Buskett and birds started attempting to roost at 15.00 hours CET. Moreover, the mean party size was significantly greater than that usually observed (*Fig. 1.*). This may be explained as follows: Parties of Honey Buzzards frequently coalesce. If we assume that this occurs with constant probability and that parties do not break up once formed, mean party-size would depend on mean distance covered across the path of other birds. If on sighting a front, Honey Buzzards head away from it, as the latter almost always travel eastwards, birds flying to the west of the Maltese Islands would often cross the path of those flying further east, increasing the likelihood of parties coalescing. Mean party size would consequently increase.

In view of the above, it seems unlikely that raptors flying ahead of fronts are using frontal systems to cross the Mediterranean. Rather, the birds appear to recognize the approach of an active frontal system as a potentially dangerous situation and make for the nearest land.

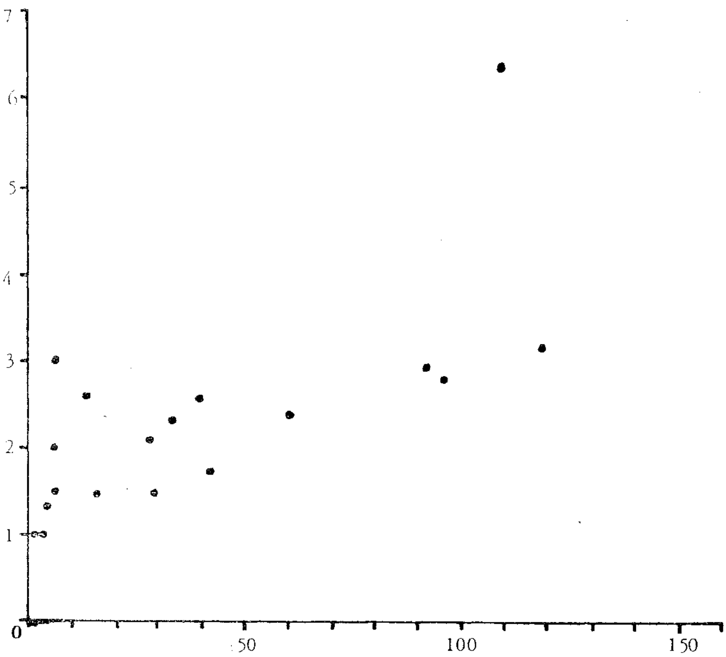

Fig. 1 Variation of mean party size with numbers of *P. apivorus* sighted on the same day. The spurious point (109, 6.4) is that obtained on 11/9/76 (P approx .01)

FLAPPING FLIGHT

Sustained flapping flight has frequently been observed in migrant Honey Buzzards crossing wide stretches of water (*Beaman et al in prep.*). This method is the least economical in terms of power requirements but a Honey Buzzard employing flapping flight to cross the Mediterranean can maximise its safety by appropriate selection of the weather conditions under which it migrates.

(1) The main purpose of this section is to justify the search for any correlation between weather and the numbers of raptors observed at Buskett.

The following hypothesis was tested: The raptor counts made at Buskett are random samples of a homogeneous, normally distributed, population, i.e. the probability of a raptor sighted belonging to a given species is constant.

Beaman and Galea (*Ref. 1*) have pointed out the marked fluctuation of daily totals. As observations in 1975 were rather shorter than those in 1976, variation in numbers between years could not be compared. In 1976 fluctuation of daily totals was most spectacular in the case of Kestrels and Honey Buzzards. The diversity of raptors observed in September 1975 was compared to that observed in September 1976 using a 2 x S homogeneity table (*Table 1*). The kestrels (*Falco naumanni/ tinnunculus*) and harriers (*Circus macrourus/pygargus*) were treated as 'species' to reduce the effect of errors in indentification. The resident Peregrines were excluded. The samples differ significantly from one another (Chi squared $\doteq$ 54.17; $P < .0001$).

The variation in diversity of raptors observed between 21/9/76 and 29/9/76 was examined. Results were inconsistent with the above hypothesis (Chi squared $\doteq$ 125.3; $P < .0001$) and it may therefore be rejected.

The anomalously high variation reported above may have arisen in a number of ways; inadequacies of the sampling method, errors in counting and identification, variation in the pattern of migration from year to year, annual fluctuation of the relative abundance of a given species, random variation in the position of the migratory streams which need not coincide and association between the probability of a raptor sighted belonging to a given species and weather conditions.

While it would be idle to suppose that the probability of sighting a raptor is independent of the size of the bird, this is neither here nor there in relation to the calculations employed. Provided the method of observation is unchanged the samples are comparable. Since it is virtually impossible to maintain a high level of alertness while scanning with binoculars, unaided visual scanning was employed in all watches. Birds were then identified using 16 x 50 binoculars. The nature of the observations allows only one determination of diversity by a given observer and it is not possible to test the data for reproducibility. There is no evidence that the observational data are not reproducible. The reasons for small sample bias in diversity measurements have been discussed by Preston (*Ref.* 8). The observed variation is however much too great to be explicable in these terms.

Flocking behaviour doubtless contributes to the observed variation of diversity. Thus variation in the number of Black Kites and Marsh Harriers accounted for almost half of the observed inhomogeneity in the between-years test. However, even if these contributions are excluded, the value of Chi squared is still significant at the 1% level.

The problems of double counting and unjustified ommission probably only become important after 15.00 CET. The number of raptors loitering in the vicinity of Buskett thereafter gradually increased until sunset. Much care was taken to avoid making double counts and in the process some birds may have been incorrectly ommitted. The writer has taken the somewhat optimistic view that these errors tend to cancel out. There is in any case no way of being certain that a particular bird has not already been counted. The situation is in fact one of sampling with incomplete replacement and the proportion replaced should vary with sample size and diversity as well as with time of day.

In principle, errors in identification could account for the observed variation in diversity. However, most of the observed inhomogeneity was due to Black Kites, Marsh Harriers, Hobbys and Honey Buzzards, species which are fairly unmistakeable. Evidently the problem is more apparent than real.

The observed variation in diversity could in principle be explained as due to variation in the migration pattern, fluctuation in the relative abundance of a given species or annual variation in the position of migratory streams which need not coincide. While these explanations can account for the heterogeneity between years, they cannot account for that observed within a given year. Random variation in the position of migratory streams during a given year is intuitively unattractive and there is no evidence that it occurs among migrant raptors. Moreover, much of the observed heterogeneity was due to species which are believed to migrate on a relatively broad front.

It has been shown beyond reasonable doubt that the probability of a raptor sighted belonging to a given species is not constant both within and between years. While sampling inadequacies could account for some of the inhomogeneity, it seems unlikely that their effect is important. There appears to be some justification in seeking correlation between meteorological variables and the numbers of raptors sighted.

(II) On a Synoptic scale, anticyclonic conditions are the most favourable for migration by flapping flight. Clear skies, low wind strengths and the absence of strong down-draughts reduce the number of problems which a bird has to overcome. Moreover, the presence of an inversion within the troposphere hinders the passage of cold fronts which are usually deflected north-east. It would therefore be reasonable to suppose that Honey Buzzard sightings are positively correlated with atmospheric pressure. Analysis of observations made in 1975 had suggested that this was in fact the case ($.01 < P < .05$). (Ref. 9)

Table 1

2 x S CONTINGENCY TABLE

HOMOGENEITY TEST FOR SAMPLES OBTAINED IN SEPTEMBER 1975 and 1976

	1975 n1	1976 n2	$\frac{(n1/N1 - n2/N2)^2}{n1 + n2}$
Osprey	3	3	3.267×10^{-6}
Honey Buzzard	217	707	1.042×10^{-5}
Black Kite	18	13	3.110×10^{-5}
Sparrowhawk	1	4	2.556×10^{-7}
Buzzard	3	3	3.267×10^{-6}
Booted Eagle	1	0	5.290×10^{-6}
Lesser Spotted Eagle	1	0	5.290×10^{-6}
Short-toed Eagle	2	4	2.686×10^{-7}
Hen Harrier	1	0	5.290×10^{-6}
Montagu's/Pallid Harrier	1	3	1.862×10^{-8}
Marsh Harrier	11	80	2.014×10^{-5}
Egyptian Vulture	1	0	5.290×10^{-6}
Hobby	113	211	2.153×10^{-5}
Eleonora's Falcon	6	22	8.119×10^{-7}
Lesser Kestrel/Kestrel	48	116	1.017×10^{-6}
Red Footed Falcon	0	1	7.355×10^{-7}
TOTALS	427	1167	
	N1	N2	

Chi squared ≐ 54.17, degrees of freedom (df) = 15.
P < .0001.

Table 2

h x k CONTINGENCY TABLE

TEST OF SAMPLES OBTAINED FROM 21/9/76 to 29/9/76 FOR HOMOGENEITY

September	21	22	23	24	25	26	27	28	29	Species Totals
Honey buzzard	44	39	33	96	92	119	29	28	60	540
Marsh harrier	3	6	20	16	9	4	5	3	8	74
Hobby	33	28	11	38	17	14	8	6	13	168
Kestrels	4	3	12	15	8	7	11	8	14	82
DAILY TOTALS	84	76	76	165	126	144	53	45	95	864

Chi squared ≐ 125.3, degrees of freedom (df) = 24
P < .0001.

Meteorological data were taken from the records of Meteorological Office Luqa and R.A.F. Qrendi. Data obtained from 30/8/76 to 10/10/76 (42 observations) were analysed.

As expected, Honey Buzzard numbers were significantly correlated with pressure at both Luqa and Qrendi. Correlation was highest with atmospheric pressure at Luqa at 19.00 CET ($r = .357$; $P < .01$) and lowest at 12.00 CET for Qrendi data ($r = .270$; $.01 < P < .05$). There are therefore good grounds for believing that Honey Buzzards cross the Sicilian Channel chiefly under anticyclonic conditions.

In principle, anticyclonic conditions may be detected in a variety of ways and Honey Buzzards may well use more than one method. Under anticyclonic conditions, wind-strengths are lower and vary less with height than under cyclonic conditions. The daily mean scalar wind strength between 0 and 1500 m (W) was calculated. Honey Buzzard numbers were significantly correlated with Qrendi data for W at 6.00 CET. ($r = -.497$; $P < .01$) (*Fig. 2*). Moreover, this correlation was better than that obtained for the individual wind-strengths and correlation with wind-strength at ground-level was no longer significant by 12.00 CET ($.05 < P$).

The above results may be interpreted as follows: Early in the day, Honey Buzzards 'decide' whether or not to cross the Sicilian Channel. Low wind-strengths within the first 1500 m are interpreted by the birds as favourable indications and favour a decision to cross the Channel.

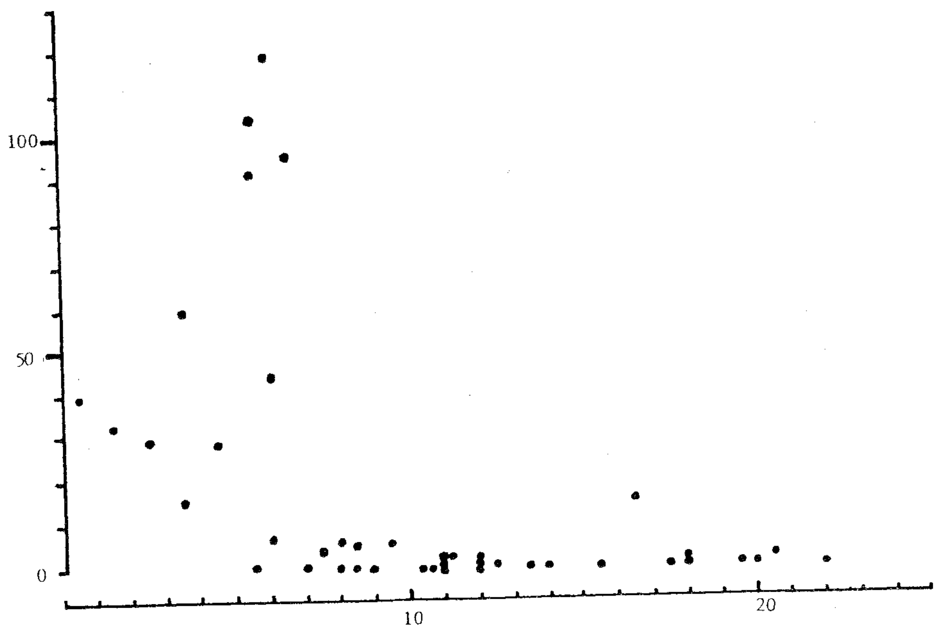

Fig. 2 Variation of Numbers of *P. apivorus* sighted with W. (mean wind strength below 1500 m at 6.00 CET in Knots: × 1.852 Km/hr). $r = -.497$; $P < .01$.

DISCUSSION

The Meteorology of the Central Mediterranean is dominated by the periodic fluctuations in intensity of the sub-tropical (Azores) anticyclone. In summer, a ridge of the latter extends towards the Alps and typically forms an anticyclonic cell over the Central Mediterranean The convective stability which results weakens those cold fronts which penetrate the Mediterranean. The calm settled weather which is characteristic of Mediterranean summers is a direct result of this. This state of affairs persists until early or mid-October when cyclogenesis, usually involving maritime polar and continental Tropical air-streams, intensifies. Troughs and depressions subsequently cross the Central Mediterranean in rapid succession.

A Honey Buzzard embarking on a crossing of the Central Mediterranean is unlikely to complete the 450 km. crossing from Southern Sicily to Libya in less than 12 hours. Birds crossing from points further north would take longer to complete the crossing, particularly if their heading has an appreciable easterly component. Moreover, the birds might fly at reduced speeds (closer to the minimum power speed) in order to lessen their power-output, in which case the crossing would take considerably longer. In opting to migrate under anticyclonic conditions, a Honey Buzzard is unconsciously making a short-term weather forecast. Anti-cyclonic cells are a more permanent feature of the weather conditions and are generally longer-lasting before mid-October than they are subsequently. The reliability of this forecast is consequently greater before mid-October than it is subsequently and Honey Buzzards making a relatively long sea-crossing would be better insured against unfavourable weather. By mid-October 99% of the Honey Buzzards and usually over 70% of all raptors observed in the Maltese Islands have been recorded.

The summer drought of the Mediterranean region is a relatively recent phenomenon. The sub-tropical convergence zone has gradually been extending northwards over the last few thousand years. Indeed 11,000 years ago, Mediterranean summers were probably similar to those experienced by western Europe today with conditions being much more variable and in general wetter. (*However see Ref. 10*). These changes are associated with fluctuations in the extent of the polar icecaps and there is good evidence that they are due to periodic changes in the Earth's orbit (*Ref. 4*). They are of course continuous and the present Maltese flora has been slow in some respects to adapt to these changes. There is a minor flowering peak in August which is out of phase with the onset of heavy rains in late September or early October (*Ref. 3, p. 83*).

When faced with such a situation, it would clearly be pointless to propose complicated behavioural adaptations for crossing the Mediterranean which depend on purely local weather conditions. Although these same conditions may appear fairly constant at present, their modification with time has been continuous and perhaps too rapid, from an evolutionary standpoint, for the appropriate adaptations to evolve.

However, although the mean position, intensity and frequency of occurrence of anticyclones and depressions may have varied appreciably, their intrinsic properties have remained unchanged. Anticyclonic conditions would always be more favourable for migration than cyclonic conditions. Any adaptations for making sea-crossings under anticyclonic conditions would not be limited in usefulness to the locally prevailing conditions alone.

This paper has dealt principally with the effects of Synoptic scale weather-conditions on the migration of *P. apivorus*. The ability of a bird to select the height, flight-style and speed at which it flies should radically alter its micro-environment. No attempt has here been made to elucidate the effect of smaller-scale meteorological phenomena.

Acknowledgements: I would like to thank M. Beaman for reading the manuscript, E. Curmi, N. Bonavia and C. Galea for supplementing my observations on a number of occasions and Messrs. Pace and Wright for allowing me to examine Meteorological records.

ABSTRACT

1. The appearance of a minority of the Honey Buzzards sighted at Buskett coincided with the approach of frontal systems. Data are presented which suggest that the birds are not using the thermals which precede these frontal systems to cross the Mediterranean. Rather, they appear to recognize the approach of an active frontal system as a potentially dangerous situation and make for the nearest land.

2. The samples of raptor-sightings made at Buskett were tested for homogeneity and differred significantly from one another ($P < .0001$) both within and between years. This is best interpreted as a distortion of the migration pattern by weather conditions.

3. On a Synoptic scale, anticyclonic conditions are the most favourable for migration by flapping flight. Indeed Honey Buzzard sightings were significantly correlated with atmospheric pressure ($P < .01$). Negative correlation with mean wind-strengths below 1500 m was better ($P < .01$). Low wind-strengths are typical of anticyclonic conditions and Honey Buzzards may use low wind-strengths as an indication of the prevalence of anticyclonic conditions. The autumn passage of Honey Buzzards occurs at a time of year when local conditions are mainly anticyclonic.

REFERENCES

1. Beaman M., Galea C. 1974, The visible migration of raptors over the Maltese islands *Ibis* 116: 419-431.
2. Gibb J., 1974, The Birds of the Maltese Islands *Ibis* 93: 109-127.
3. Haslam S.M., 1969, Malta's plant life. Progress Press Malta.
4. Hays J.D., Imbrie J., Shackleton N.J., 1976, Variations in the Earth's orbit: pacemaker of the ice ages. *Science* 194 (4270): 1121-1131.
5. Moreau R.E., 1953, Migration in the Mediterranean area *Ibis* 95: 329-364.
6. Moreau R.E., 1961, Problems of the Mediterranean – Saharan migration *Ibis* 103a: 373-427, 580-623.
7. Moreau R.E., 1972, The Palearctic-African bird migration systems. Academic Press London and New York.
8. Preston 1962, The canonical distribution of commonness and rarity. *Ecology* 43: 185-215, 410-432.
9. Thake M., 1976, Visible migration of raptors over Buskett – Autumn 1975. *Il-Merill* (17): 21-24.
10. Wright H.E. 1976, The environmental setting for plant domestication in the near east. *Science* 194 (4263): 385-389.

Erratum: IL-MERILL No. 17 page 24

Bottom line of Table 2 should read:

Hobby	**139-233**	**115**	**17.51%**	**48.7%**
