THE CLIMATE OF THE DALE PENINSULA, PEMBROKESHIRE

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STUDIES of local climates in the British Isles have received only limited attention. The gap between large-scale regional climatic surveys and the detailed investigation of the characteristics and smaller-scale variations of small areas has not been adequately bridged. Most of the available local climatic studies are directed to special aspects, such as urban climates, or the climates developed under selected relief conditions, e.g. inversion hollows. The exceptions to this statement are the series of local climatic analyses which have appeared in the regional handbooks prepared for the post-war meetings of the British Association for the Advancement of Science.* In most cases these were related to the town or city in which the meeting was arranged. They devoted less space to regional variations of local climate than to general climatic descriptions and gave little insight into the qualities of a rural climatic environment.

The survey of the climate of the Dale Peninsula has been restricted to the parish of Dale. The details of the general climate are given first, while local contrasts are discussed in the second part.

The peninsula, situated approximately 5° 10′ W and 51° 42′ N, has an almost uninterrupted exposure to oceanic influences from the south and west. The peninsula of southern Pembrokeshire affords some shelter on the east. On the landward side there is only limited shelter since the Prescelly Hills are well to the north. The extensive development of a low coastal plateau at about 200 feet above sea level permits free access to weather conditions imported into the peninsula. Over considerable areas there is uniformity of aspect and exposure. The east to west extent of the peninsula is about 1½ miles so that the southernmost parts of the parish have many of the qualities of an ocean-based station.

THE GENERAL CLIMATE

Two sources of information have been used as the basis for this section. The record of St. Ann's Head,† a telegraphic reporting station, extends from 1872-1951. In 1950 Dale Fort† was established as a third order climatological station recording data at 9 G.M.T. and the St. Ann's Head values terminated in June, 1951. The overlap between the two records is too short to permit reliable

* For example, those for Birmingham, Edinburgh, Liverpool, Oxford, Bristol, Sheffield, Dublin and Glasgow.

† The heights of the rain gauges above M.S.L. are St. Ann's Head 142 ft., Dale Fort 109 ft.

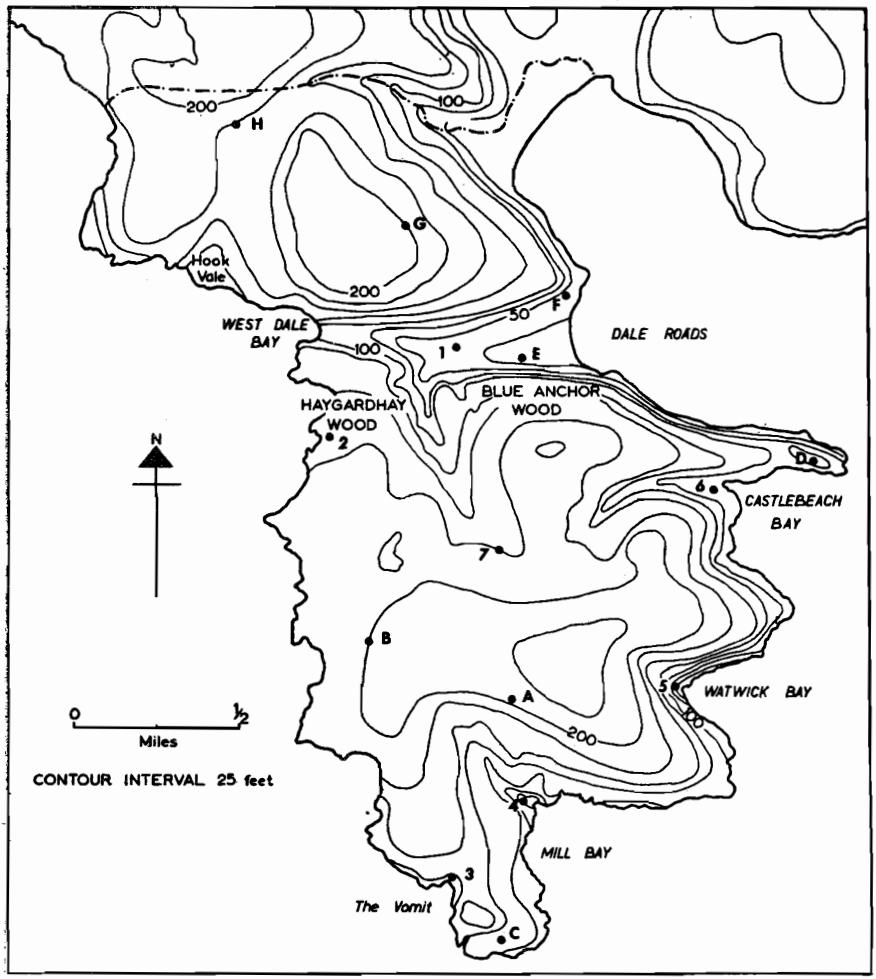


FIG. 1

Dale Parish showing general relief and the location of recording stations. The height above sea level is indicated after the station name. Sites numbered 1-7 refer to the location of the soil temperature observations.

A. Brunt Farm, 210 ft.
B. H.M.S. *Harrier* (Kete), 200 ft.
C. St. Ann's Head, 142 ft.
D. Dale Fort, 109 ft.
E. Dale Village, 20 ft.
F. Dale Village, 45 ft.
G. Upper Dalehill Farm, 200 ft.
H. H.M.S. *Goldcrest* (Dale Aerodrome), 210 ft.

corrections in order to establish one homogeneous record and consequently the climatic data in Tables 1 and 2 have been presented separately for each station. The St. Ann's Head station projects south towards the ocean and is more exposed than Dale Fort, which gains some shelter between south-west and north-west from the peninsula which rises to just over 100 feet above it.

(1) *Temperature*

The oceanic qualities of the area are strongly apparent in the temperature record. The absolute extremes have a much lower range than for areas in central England or, for that matter, in south-east Wales. The lowest and highest temperatures are associated with the westerly extension of continental air masses and their time of occurrence is more in keeping with the periods of the year when such air masses have their extremes of heat or cold. The highest monthly mean maximum and lowest mean minimum values show a range much less than that of east coast or inland stations in southern Britain. The time of occurrence of the extreme hottest and coldest months, like that of the absolute extremes, is dependent upon extended spells of "continental" air. The highest monthly maximum occurred in July and the lowest monthly minimum was in February. The months of mean maximum and minimum temperatures are later in the year, a characteristic of strongly oceanic temperate latitude climates. In this connection it will be noticed that August and February are respectively the warmest and coldest months. The mean maximum temperatures are higher in winter and lower in summer than in less oceanic stations. The mean minimum temperatures tend to be higher than in inland stations at all times of the year, but most of all in the winter months. This latter feature is apparent compared even with Haverfordwest only 11 miles away in a direct line. Both the annual and daily ranges of temperature are small. The mean daily ranges for Dale 1950-57 reveal values well below those of less maritime parts of the British Isles. Even for the months from April to July when solar control becomes more significant they do not exceed 11° F.

In Fig. 2 the mean sea temperatures derived from only a short and incomplete set of readings for 1955-58 and taken at 1 foot depth just to the north of Dale Fort have been plotted. The comparison between the monthly average and mean maximum air temperatures and the values and trend of the water temperatures is instructive. The water temperatures would appear particularly to reduce the mean maximum air temperatures. It is also apparent that the spring air temperature rise and the autumn decline are delayed as compared with an inland station.

If the threshold temperature of 43° F. for plant growth is considered significant, it is noteworthy that only the February mean temperature falls below this value. In the period 1921-50 fifteen Februaries had a mean temperature above 43° F. The temperature check to plant growth is small and pasture grasses remain dormant for but a short period. The mean daily temperatures for Dale, 1950-58, show that the temperature was above 43° F. from 15th March to 2nd January. Only two of the first fourteen days of March had mean temperatures slightly less than this value. Exposure to wind is a far more serious limiting factor than cold.

Table 1. *Temperatures at St. Ann's Head* (A) 1872-1950 *and Dale Fort* (D) 1950-57

Degrees F.

	J	F	M	A	M	J	J	A	S	O	N	D	Year
(1) Average monthly temperatures.													
A	43·2	42·5	43·4	46·6	51·0	55·9	58·7	59·4	57·0	52·3	47·6	44·8	50·2
D	*42·7*	41·4	44·6	47·6	51·5	57·2	60·4	60·3	57·6	53·4	48·1	46·1	*51·1*
(2) Average daily maxima and minima.													
A	46·2	45·6	47·3	50·9	55·7	60·3	62·7	63·2	60·7	55·8	51·0	47·9	54·0
D	*46·4*	45·6	48·7	52·8	56·2	62·5	65·5	64·9	61·5	57·3	51·6	49·6	*55·5*
A	40·2	39·3	39·5	42·3	46·3	51·4	54·7	55·5	53·2	48·8	44·3	41·6	46·4
D	39·2	37·3	40·4	42·5	46·8	51·7	55·2	55·7	53·7	49·6	44·7	42·7	46·7
(3) Highest and lowest monthly mean maximum and minimum.													
A	50·1	50·0	51·6	57·4	60·1	65·5	69·8	69·2	66·8	60·6	54·6	52·5	56·3
D	*48·7*	48·9	52·3	54·5	60·1	66·2	70·5	71·4	64·4	58·4	53·9	52·4	*56·6*
A	31·0	27·9	34·3	37·7	43·5	48·1	51·6	51·9	49·8	43·1	37·8	33·7	43·9
D	36·2	30·8	35·3	40·7	44·3	50·3	53·5	53·7	50·2	48·2	41·7	36·7	46·1
(4) Absolute extremes (Dale Fort January, 1950 to October, 1958).													
A	56	56	64	70	75	81	82	82	74	69	61	57	82
D	*54*	52	59	65	74	81	78	83	71	66	59	57	83
A	19	22	22	28	32	38	43	45	38	33	28	19	19
D	24	20	26	30	35	44	48	49	43	35	33	27	20
(5) Mean diurnal range for Dale Fort, 1950-57.													
D	6·6	8·2	8·6	10·4	10·7	10·7	10·3	9·2	7·7	7·6	6·9	6·7	8·6

Notes: (1) Values in italics for Dale Fort refer to a 6 year period.
(2) The absolute extreme maximum temperature for August probably reached 84° F. on 17th August, 1947, but the St. Ann's Head record was incomplete. Tenby registered 84° F.

(2) *Relative humidity*

The high relative humidity values of the peninsula reflect the oceanic location and the frequency with which maritime air-masses influence the weather. A marked feature of the hygrograph traces of four self-recording instruments, which were operated in connection with this investigation, was the frequency with which relative humidities of 95 to 100 per cent were recorded, often for a considerable proportion of a week. At these times the air-mass dominated temperature, reducing its diurnal variation to 2-4° F. Such periods were often associated with wet mist and stable conditions. Modified polar maritime and especially tropical maritime air-masses are the main source of air with a high relative humidity The combined effect of moderate temperatures and high relative humidity influences the evaporation of soil moisture. This is of some importance in an area, which, for Wales, has a relatively dry climate. Irrigation is probably a desirable thing in the coastal regions of Pembrokeshire in the summer months of many years. This is the conclusion which can be drawn from a comparison between calculated evaporation values and summer monthly precipitation totals. Wet mists must be allowed for, however, although rain-gauge readings will probably give no indication of their occurrence. There is a need for further investigation of this point. The lowest relative humidities occur in spring and early summer and early autumn.

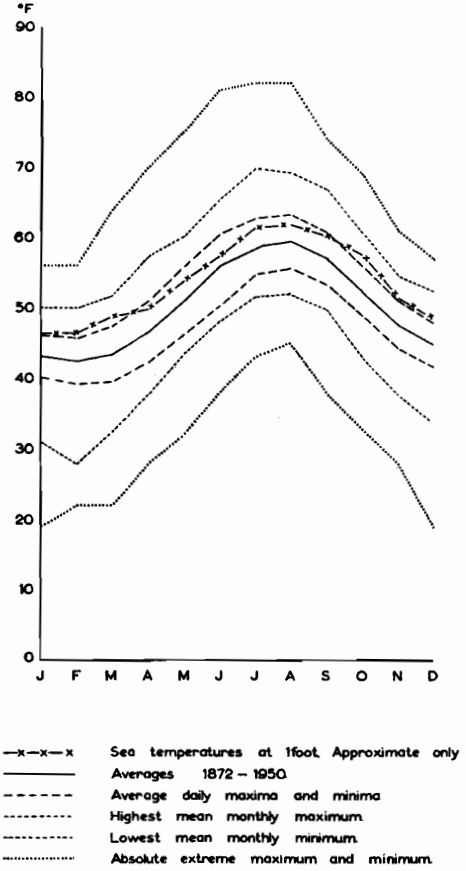


FIG. 2

Air temperatures at St. Ann's Head, 1872-1950, within the Stevenson screen. The sea temperatures are based upon daily maximum and minimum values recorded by the Field Centre, 1955-58 (some values missing) at 1 foot depth.

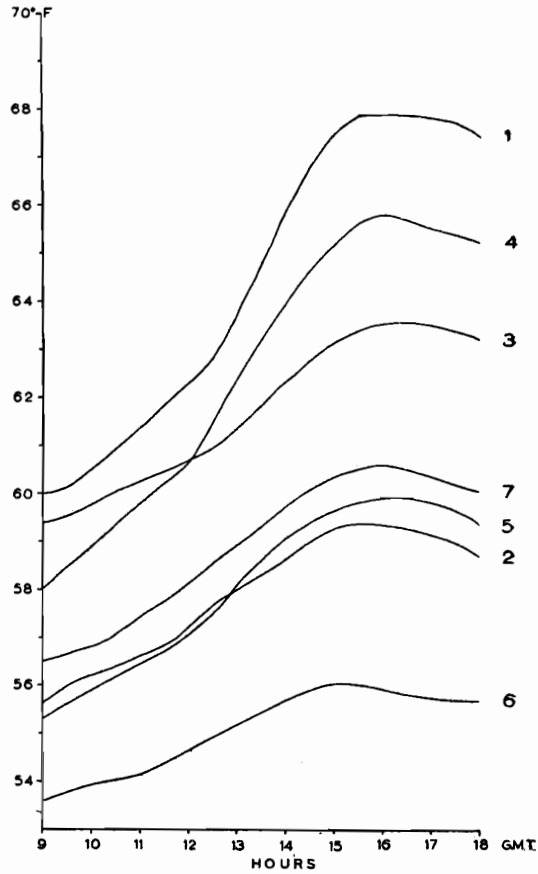


FIG. 3

Soil temperatures at 4 inches depth on 28th June, 1958. Refer to Fig. 1 for the location of observing sites.

(3) *Rainfall*

The importance of frontal rainfall, derived from the movement of depressions across the southern half of Wales, is indicated by the precipitation régime (Fig. 4). The higher totals of the autumn and winter months are clearly emphasized. There is, however, a moderately high rainfall in August perhaps reflecting the slightly greater instability produced in the coastal fringes by the higher temperatures over the land. The driest conditions occur in April, May and June. September is somewhat drier than August or October. These characteristics can be seen in the St. Ann's Head figures but the short Dale Fort record shows some exceptions. At these drier times of the year there is a stronger tendency to anticyclonic conditions and, as the wind-roses for April, May and September reveal, there are then anomalous increases in winds from between north-east and south-east. March, however, with many such winds is not quite so dry.

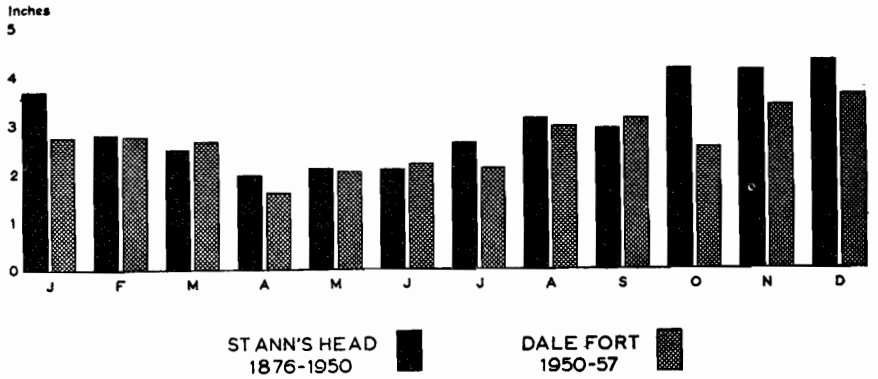


FIG. 4

Rainfall régime at St. Ann's Head (1876-1950) and Dale Fort (1950-57).

The rainfall totals recorded are amongst the lowest in South Wales. The Dale Peninsula shares the lower rainfalls, below 45 inches per annum, which characterize the coastal margins of Cardigan and Carmarthen Bays. It is often suggested that gauges located on or near cliffs under-record because of the upsweeping effect of on-shore wind eddies. The more sheltered Dale Fort readings, however, appear to be significantly lower than those at St. Ann's Head. This was revealed in the short period over which the two records overlapped as well as being suggested in the mean values of the two stations. When rainfall is derived from frontal rain belts, periods of several hours rain are often characteristic, and under these circumstances heavy falls and wet months are as probable on the coastal fringes as further inland. In the months of the year most likely to be thus affected, in the St. Ann's Head record for 1916-50, totals over 7 inches were recorded in each month on several occasions over the years.

Table 2. *Rainfall and weather conditions at St. Ann's Head* (A) *and Dale Fort* (D). (*Averages or totals as specified*)

	J	F	M	A	M	J	J	A	S	O	N	D	Year
						Inches							
(1) Average rainfall (St. Ann's Head, 1876-1950; Dale Fort, 1950-57).													
A	3·69	2·77	2·47	1·94	2·06	2·03	2·59	3·09	2·88	4·10	4·04	4·24	35·89
D	2·71	2·72	2·61	1·57	2·00	2·15	2·08	2·91	3·09	2·49	3·34	3·56	31·23
(2) Average rain-days [0·01 inches or more in a day] (St. Ann's Head, 1916-50; Dale Fort, 1950-57).													
A	20·3	15·5	15·0	13·7	13·9	11·5	14·8	14·9	15·9	17·8	18·8	19·6	192
D	17·0	16·5	14·1	10·3	12·1	10·5	12·5	14·5	18·3	16·6	15·9	19·5	178
(3) Average wet-days [0·04 inches or more in a day] (St. Ann's Head, 1916-50; Dale Fort, 1950-57).													
A	16·0	11·4	11·3	10·0	9·8	8·8	10·3	11·1	12·0	14·2	14·6	15·3	145
D	12·5	12·1	10·0	8·0	8·8	8·1	8·8	10·4	15·9	11·5	12·6	13·8	132
(4) Days with snow falling (totals for St. Ann's Head, 1921-50; Dale Fort, 1950-57).													
A	43	52	40	17	1	0	0	0	0	1	5	24	183
D	9	15	6	4	0	0	0	0	0	0	2	2	38
(5) Days with ground frost (Dale Fort totals, 1950-57).													
D	44	56	26	9	1	0	0	0	0	2	15	19	172
(6) Days with air frost (Dale Fort totals, 1950-57).													
D	24	49	19	1	0	0	0	0	0	0	0	5	95
(7) Days with thunder heard (totals for St. Ann's Head, 1921-50; Dale Fort, 1950-57).													
A	5	1	4	6	12	15	11	18	16	13	11	4	116
D	2	1	1	1	3	5	5	4	3	2	0	4	31
(8) Days with fog at 9 G.M.T. (St. Ann's Head averages, 1921-50; Dale Fort totals, 1950-57).													
A	1·4	1·6	2·2	1·8	1·9	2·2	2·1	1·7	1·4	0·6	0·7	0·7	17·2
D	10	8	15	8	4	10	4	3	7	3	2	1	75
(9) Relative humidity (St. Ann's Head, 1921-31, 1933-35; Dale Fort, 1950-57).							Per cent.						
A 7h	90	90	90	90	88	88	90	90	89	88	88	90	89
13h	88	87	82	81	82	83	83	84	82	83	85	87	84
18h	88	88	85	83	83	83	85	85	86	86	86	89	85
D 9h	86	84	86	79	81	82	82	85	83	84	84	85	83
(10) Sunshine mean monthly totals (St. Ann's Head, 1921-50; Dale Fort, 1952-57).							Hours						
A	48	69	125	167	206	218	185	179	135	98	61	43	1,534
D	67	103	148	217	249	242	201	193	158	108	69	54	1,809

Notes: (1) The Dale Fort record is not complete in all respects for the earlier years hence the variations in the periods to which data are referred.

(2) The St. Ann's Head rainfall record started in 1877. For Section 1 the values have been extended back to 1876 to give a 75 year record. Alterations to the rain-gauge site necessitated a correction to amounts recorded from 1940 to 1950.

(3) The St. Ann's Head values in Sections 9 and 10 are based on the averages published by the Meteorological Office. Other values have been calculated from the data in the Monthly Weather Report.

November, December and February have recorded as their highest totals (1916-50) 9·95 inches (1929, the highest monthly fall collected), 9·28 inches (1929) and 9·32 inches (1923) respectively. The greater concentration of rainfall in the winter period (October to March) is revealed in the ratio of the amount received then to that for April to September, 59 : 41.

The sequence of weather can be readily appreciated from the vantage point of the western facing cliffs. Dale has a reputation for sudden clearances after periods of rain. No continuous rainfall record is available to confirm this impression, but it is to be expected since local conditions are less likely to extend the duration of a frontal belt by local instability rainfall as can occur in inland areas or in coastal fringes backed by rising ground. Bearing in mind the frequency of coastal mists or low stratus the high sunshine totals lend further support to this view.

The proportion of annual totals of wet-days* to rain-days works out almost exactly at 3 : 4. The average total number of days on which at least 0·01 inches of rainfall will fall in a year (192) is less than that experienced in lowland areas further east in South Wales, e.g. Swansea 205 (1916-50), and considerably less than the inland and upland parts of Wales where rainfall duration and intensity are both greater. The oceanic characteristics of the climate are apparent, however, in the higher total of rain-days at St. Ann's Head as compared with eastern England stations. Days with drizzle are a feature of such a coastal station on the west coast.

(4) *Snowfall and snow-cover*

The mildness of winter conditions and the infrequency with which the extreme severity of continental polar air extends as far west as Pembrokeshire is clearly expressed in the small number of days on which snow or sleet is observed. Even in these cases the fall is often slight and the figures exaggerate the frequency of significant snowfall. The occasions of snow-lying are so spasmodic that no average figure can be calculated. It is an unusual event for snow to remain for a period of days or even 24 hours upon the ground, and in many years when snow is recorded as having fallen no days with snow cover at 9 a.m. occurred. The delay in minimum temperatures and the tendency to more frequent easterly winds after January contributes to the occurrence of snow falls in the spring months of March and even April. Snow is not a significant climatic feature in lowland Pembrokeshire. When it does occur it is usually when depressions or unstable troughs develop in a deep polar or arctic north or north-east air stream.

(5) *Frosts*

Ground frosts and air frosts† are small in number as compared with more easterly locations in coastal South Wales and far fewer than at a similar latitude in central or eastern England. November and December ground frosts are infrequent. The months with the greatest number of ground frosts are January to March. The frequency of April frosts is markedly less than that in the

* A rain-day receives 0·01 inches of rain or more, a wet-day 0·04 inches or more.

† Grass minimum 30·4° F. or below and screen minimum 32° F. or below respectively.

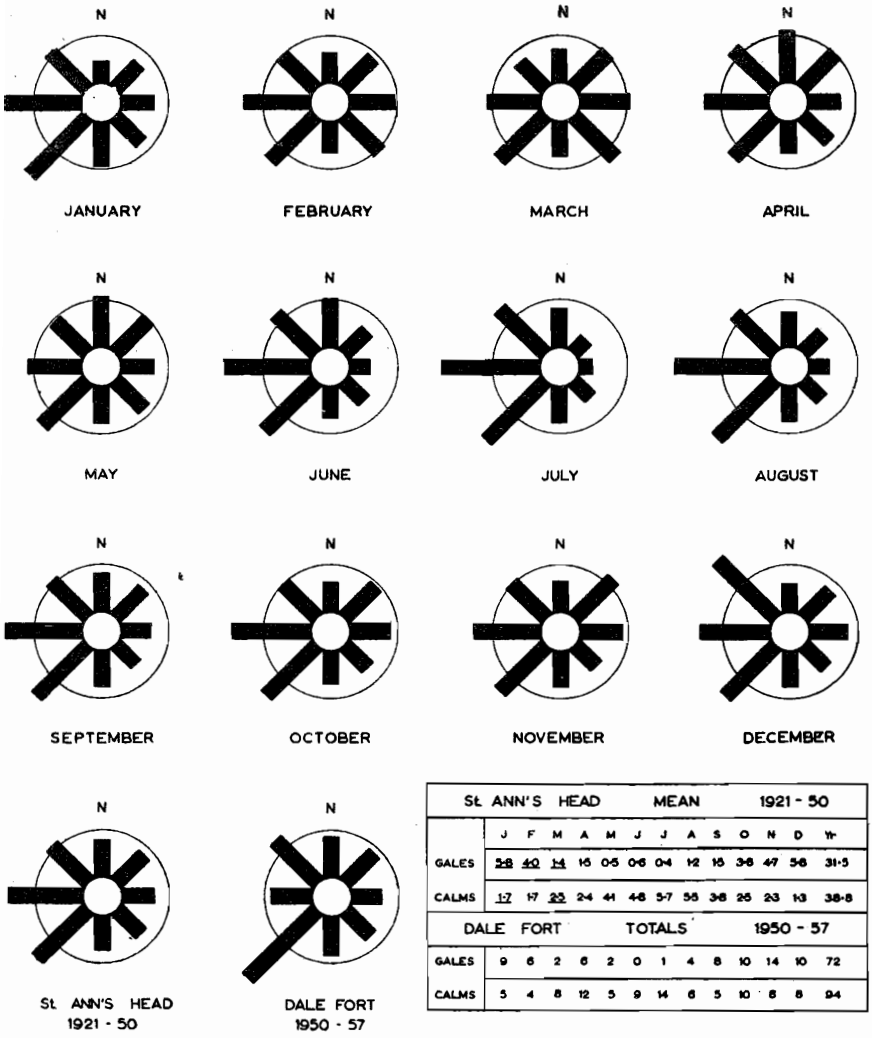
preceding month. It is fortunate that air frosts are relatively few and that, except in harsh periods, ground frosts are rarely severe from early spring onwards. The oceanic amelioration of frost risk is of the utmost importance to the success of early potato growing. An unexpected severe early spring frost can be a disastrous event (Dresser, 1959). Relatively short distances inland, towards Haverfordwest and especially where inversion hollows exist, the liability to more frequent and severe frost increases considerably.

(6) *Thunder heard*

The record of thunder heard is a composite one. Summer thunderstorms are a far less frequent feature than in the east of Britain or central Wales, but there is, nevertheless, a concentration of the few thunderstorms of longer duration in the summer months. These develop in connection with an unstable polar north-westerly air stream or more particularly with the northward movement of a cold front from the Bay of Biscay or the South-western Approaches. Local super-heating is usually insufficient a cause by itself. In the winter months there is a second source of thunder. In these cases there is often a single thunderclap related to the passage of a particularly unstable cold front often in association with a polar maritime air-mass. Winter coastal thunderstorms and instability showers are, however, less characteristic than in W. Scotland or N.W. Ireland. Even from these two sources the total figures are small and an intense thunderstorm is a rarity at such an oceanic situation. The lack of large contrasts between the sea and land is unfavourable to locally developed instability.

(7) *Sunshine and visibility*

Dale Peninsula enjoys much higher sunshine totals (Table 2 (10)) than might be expected from experience of the cloudier, rainier conditions in much of Wales, especially the central uplands. The development of cloud cover as the result of mechanical and thermal turbulence often takes place inland from the immediate coastal fringe. Thus it is that for localities near to the sea-cliffs unexpectedly high sunshine totals will be received. These are accumulated despite the frequency of summer wet mists and low stratus cloud. The fact that most of the air movement is from over the ocean west of Dale contributes to the low pollution of the atmosphere. Visibility shows two striking correlations with wind direction. Poor visibility conditions are associated first with south-west or west winds when wet fog or low stratus cloud is blown in with a stable maritime air-mass. A secondary maximum of poor visibility develops when south-easterly winds are persistent and import the industrial pollution of south-east Wales. Quite sudden improvements in visibility are a feature of the weather. Within a short interval visibility may improve from a mile or two to over eighteen miles. This phenomenon is related to the more distinctive qualities of different air-masses in oceanic conditions where the reduction of surface friction and lack of contrasting land surfaces limit the surface modification of air-mass qualities. Most of the coastal fogs are in fact wet mists and are concentrated much more in the summer months than in the autumn. In inland locations radiation cooling can be far more effective in producing ground fog,



St ANN'S HEAD MEAN 1921 - 50													
	J	F	M	A	M	J	J	A	S	O	N	D	Yr
GALES	3·8	4·0	1·4	1·6	0·5	0·6	0·4	1·2	1·6	3·8	4·7	5·8	31·5
CALMS	1·7	1·7	2·3	2·4	4·1	4·8	5·7	5·5	3·8	2·5	2·3	1·3	38·8

DALE FORT TOTALS 1950 - 57													
GALES	9	6	2	6	2	0	1	4	8	10	14	10	72
CALMS	5	4	8	12	5	9	14	6	5	10	8	8	94

FIG. 5

Wind-roses for St. Ann's Head based upon readings four times daily, 1921-50. Dale Fort annual wind-rose based upon 9 G.M.T. readings, 1950-57. Data tabulated for calms determined from the same records. Mean values, gales and calms, are given for St. Ann's Head and totals for Dale Fort. The figures underlined are for a 29-year period only.

often giving an autumn maximum. Radiation fogs may develop in the eastern facing valleys with gentle south-east winds and anticyclonic conditions, and there may be a drift of this fog on to the main plateau by the early hours of the morning. Such fog disperses rapidly after sunrise.

(8) *Wind direction and force*

The percentage wind frequencies for the different months of the year have been calculated from the four readings per day given in the Monthly Weather Report for St. Ann's Head for 1921-50 and are shown in Fig. 5. It is interesting to observe that westerly winds are more frequent than south-westerly winds in all months except January, March, May and December. The annual percentage frequencies of west and south-west winds were 19·5 per cent and 18·7 per cent respectively. The increase in winds from an easterly quarter is notable in February and March while the high total of south-east winds in March and of north-east winds in November are other features of interest. On the whole the winds from points other than south-west or west are fairly evenly distributed in the other months of the year. Wind speeds have not been graphically represented* but high wind speeds are more common on the coast and the consequent importance of exposure to their dessicating and damaging effects is a matter of interest to the farmer. The number of gales (force 8 or over, 39 m.p.h. and above) and calms for the period 1921-50, shown in Fig. 5, speak for themselves. St. Ann's Head had the rather unenviable record of one of the highest wind velocities in the British Isles, when the anemometer reached its limit of 113 m.p.h. on 18th January, 1945. Kete recorded 109 m.p.h. on 30th November, 1954. Severe gales occur usually with south-west or west winds in winter in association with frontal squalls, sometimes giving gusts up to 90 m.p.h. or even higher. Although south-east gales do occur, gusts in pre-depression east or south-east winds rarely exceed 60 m.p.h.

LOCAL CLIMATIC VARIATIONS

The general uniformity of relief in the parish and the proximity of all parts to the sea would lead one to expect a similar uniformity in climate. In fact some noticeable contrasts were observed between records kept in different parts of the parish. Fig. 1 illustrates the dissection of the coastal plateau by small but quite deeply incised valleys which are mostly drained to the south or east. These minor variations in relief permit differences of exposure and aspect to develop. In addition to these contrasts which are to be expected, there exist differences between the eastern and western and the coastal and "inland" parts of the peninsula. These observations are based upon additional short period records for two Royal Navy land stations, H.M.S. *Harrier* (Kete) and H.M.S. *Goldcrest* (Dale aerodrome), upon four stations at which daily readings or thermo-hygrograph records were maintained during parts of 1957 and 1958, and upon some additional sites at which short-duration investigations were made. The locations of these various sites are indicated on Fig. 1.

Significant local differences in temperatures were revealed. The records of

* See the *Climatological Atlas of the British Isles*, M.O. 488 of 1952, for wind force and direction roses for the period 1935-43.

the various stations did not permit many calculations of mean values to be made, but on the basis of frequency counts from individual day records at different stations either of maximum or minimum temperatures or dry bulb temperature readings at 9 a.m. some interesting differences appeared. For periods during 1956 to 1958 comparisons were made between Kete and Dale Fort. Six hundred and four dry bulb readings at 9 a.m. were compared. The percentages of differences in different categories are shown in Table 3.

Table 3. *Deviations of Dale Fort 9 a.m. dry bulb readings from Kete*

Differences in tenths of degrees F.	−6 to −10	−1 to −5	Same	+1 to +5	+6 to +10
Percentage of cases	3·5	12·1	4·0	25·3	23·3

Differences in tenths of degrees F.	+11 to +15	+16 to +20	+21 to +25	+26 to +30
Percentage of cases	7·8	4·3	2·8	2·8

A few readings were outside the limits of the table. Only 17·7 per cent of the readings were negative. The greater warmth at Dale Fort, although of small magnitude, appears to be sufficiently persistent to be a significant local climatic feature. The maximum and minimum temperatures were similarly compared. For a slightly smaller and different sample, it was observed that Dale Fort had only 11·6 per cent of its minimum temperatures and 10 per cent of its maximum temperatures below those at Kete. The percentages of minimum and maximum temperatures which were the same at both stations were 15·5 per cent and 30·5 per cent respectively. Once again the generally higher temperatures at Dale Fort are confirmed. Grass minimum temperatures were also compared. After discarding a number of obviously suspect readings from Kete, it was found that an entirely different pattern was revealed since Dale Fort recorded 19 per cent identical readings and 48 per cent less than Kete. The height difference of 91 feet between the two stations is not sufficient to explain these various contrasts which are much more probably related to difference in location and degree of shelter.

Table 4. *Deviation of Dale Fort readings from St. Ann's Head for* 1950

	Degrees F.											
	J	F	M	A	M	J	J	A	S	O	N	D
Mean max.	—	+1·0	+2·1	+2·1	+3·4	+3·1	+2·1	+2·3	+1·2	+1·4	+1·6	+1·6
Mean min.	−2·2	−1·1	−0·4	−1·5	−0·9	−0·2	−0·3	−0·4	−1·2	−0·6	−1·4	−0·5
Mean dry bulb at 9 a.m.	+0·2	+0·1	−0·8	+0·6	−0·7	+0·5	−0·3	+0·2	−0·1	−0·5	+0·1	+0·1

The Dale Fort and St. Ann's Head records overlapped for a short period in 1950 and 1951. A comparison was made for 1950; 78 per cent of the Dale Fort maximum values exceeded those at St. Ann's Head, and 12·2 per cent were

the same. The Dale Fort minimum temperatures were above those of St. Ann's Head on only 19·4 per cent of the occasions and below on 38·2 per cent. These contrasts suggest that the St. Ann's Head record was the more oceanic of the two: Dale Fort clearly showed a greater diurnal range. Dale Fort had a slight advantage in the 9 a.m. dry bulb values, with 55·9 per cent higher and 35·1 per cent lower readings. The calculated mean values, in some cases for less than a full month, are set out in Table 4. Greater sunshine totals, some degree of shelter from the west and north-west but greater exposure to the east at Dale Fort may be some of the reasons for the small but clearly apparent differences. The height difference is only 33 feet.

Daily records were kept from February, 1957 to August, 1958 at Brunt Farm and in Dale village. The Brunt Farm records substantiate the impression gained from the comparisons between Dale Fort and Kete. Brunt Farm had consistently lower maximum and minimum temperatures than Dale Fort, and the monthly mean temperatures at Brunt Farm were frequently lower by 1 to 2° F. The location of Brunt Farm is fairly similar to that of Kete in its height and exposure to winds from all directions. The Dale village site (F on Fig. 1) was set up in a wall-enclosed garden just above the valley floor with a southerly aspect. Compared with Dale Fort a significantly greater mean diurnal range of temperature was noticed in each of the 18 months for which a check was made. The minimum difference was in March, 1957 when the Dale village site had a range of only 0·9° F. above that of Dale Fort. Differences of between 2° and 3° F. in the mean diurnal range for individual months were common and the greatest contrast was one of 3·2° F. in June, 1958. The Dale village maximum readings were higher and the minimum readings lower than those at Dale Fort. The mean values at the two stations differed but little, Dale Fort coming out most frequently slightly warmer but at the most (October, 1957) only 0·8° F. above. The contrast revealed in this comparison suggests that Dale village had slightly more "continental" features of temperature. Thus two localities about 1 mile apart have measurable temperature differences. If these and other local climatic contrasts were supported by longer period checks they would have some practical importance in agriculture and in the differentiation of local ecological habitats.

A second record of temperature by means of a thermograph was kept in Dale village (Site E). Space forbids a detailed comparison between the two Dale village sites but one feature is worthy of mention. Under suitable weather conditions temperature inversions produced quite startling differences of several degrees in the two stations. Dale village station E was situated in nearly the lowest part of the Dale Valley overlooking the Meadows in a much more open location than the garden site. On other occasions the inversion affected both sites and they recorded lower values than Dale Fort or the higher stations on the plateau. Two remaining temperature records extend the picture of regional contrasts. Records were kept at Dale aerodrome (see Fig. 1) which overlapped for a period with those at St. Ann's Head. Temperature records taken at the two stations eight times per day were compared for selected months. The higher and more inland station of the aerodrome showed many contrasts with St. Ann's Head among which were the generally lower temperatures in January and February, especially at night, and the lower temperatures

after midnight, but higher temperatures in the early afternoon to late evening for the months of April, July, August and September. A check was not made for the other months of the year. The more inland qualities of the aerodrome temperatures are suggested. A thermograph record maintained at Upper Dale Hill Farm (see Fig. 1) was compared with that at Brunt Farm and with the maximum and miminum readings at Dale Fort. Upper Dale Hill showed a tendency for its minimum values to be higher than those at Brunt Farm and for its maximum values to be lower. Compared with Dale Fort the Upper Dale Hill had lower maximum and minimum temperatures which reveals a similarity in this respect with Kete. A fuller analysis of these various patterns of temperature difference is needed to confirm the tendencies observed. There is here an opportunity for field investigation both on a short and long term basis.

Soil temperatures as well as air temperatures affect plant growth and soil fauna. To help fill a complete gap in this data a four-day period of soil temperature readings at 4-inch depth was made in June, 1958. The results of some of these readings for one selected day of sunny conditions and a light south-west breeze are represented in Fig. 3. Some major differences in soil temperatures are revealed. Many factors in addition to air temperatures and sunshine operate, such as soil texture, colour and moisture content as well as slope and vegetation cover. A much fuller investigation would be needed adequately to indicate and explain the soil temperature variations over the parish. Here is another way in which field investigation, even for short periods, would provide interesting information. Within the obvious limitations of the data collected there appeared clearly marked differences which, if they were persistent for all or even part of the year, would be highly significant both to the farmer and the ecologist. Observations on the other three days under different weather conditions rather unexpectedly gave almost the same relative positions for the different soil temperature curves but with different absolute values and amplitudes of variation. The site factor would therefore appear important. Once more the idea of uniformity of local climate is dispelled.

Local variations in sunshine could not be adequately examined since the only concurrent records were for Dale Fort and Kete and deficiencies in the latter prevented the determination of monthly totals. The possibility of faulty estimation of the burns on sunshine cards is considerable and this must be borne in mind when comparing the records. There were several instances, about 10 per cent of the days, when Kete had between 1 and 4 hours less than Dale Fort and about 6·5 per cent of the cases in which this situation was reversed. When low stratus or coastal fog blows in over the coast, perhaps as the result of sea breezes, it may often reach only a few hundred yards inland. Kete in its higher cliff-top position on the west coast of the peninsula is more liable to such periods of sea mist while Dale Fort may be less affected or even clear. In 45 per cent of the 200 days compared, the Fort had higher sunshine totals. In 30·5 per cent of the cases Kete had the advantage. A comparison between the sunshine totals at the eastern end of Dale valley and elsewhere in the parish might well give higher sunshine values than the south or west of the parish unless infrequent inversion mists partly offset this advantage.

Regional variations in rainfall are quite distinctive. The western half of the peninsula is wetter to a noticeable degree than the eastern part. Comparisons

were made between Dale Fort and records at Brunt Farm, St. Ann's Head and Kete and also between the aerodrome and St. Ann's Head. Dale Fort was drier than each of the stations with which it was compared not only in annual totals but in particular months and for most individual falls. In the 18 months over which readings were taken at both Brunt Farm and Dale Fort, the latter station received higher totals in only 2 months. Brunt Farm received 7·04 in. or 15·1 per cent more rain and recorded 24·3 per cent more rain-days. Brunt Farm recorded more rain-days in every month except one when the number was the same. A comparison between St. Ann's Head and Dale Fort for January, 1950 to June, 1951 showed that the former had 12·93 in. or 24·9 per cent more rain although it had only 3·7 per cent more rain-days. Only 2 months were wetter at Dale Fort. A brief check for the months of January, February, April, August and September, 1945, showed the aerodrome to be 6 per cent wetter than St. Ann's Head. Rainfall totals were not generally available for particular months for Kete but in the majority of individual rainfall readings Dale Fort had a lower value. Over an 8 month period Kete received 16 per cent more than Dale Fort. The greater rainfall of the higher west is therefore constantly confirmed and the amount of difference is quite sufficient to have a practical significance. Several rain-gauges sited in varying conditions of relief and exposure would provide an interesting pattern of differences.

The liability of the peninsula to fresh or strong winds accentuates the value of shelter. Southern Ireland and St. David's Peninsula give some protection from winds from between west and north-west. Some shelter is afforded by the land to the north and across Milford Haven to the east. Minor relief depressions and valleys play an important part in influencing the direction and force of the wind. Except for the col-like head of Dale Valley above Westdale Bay, no large valley opens out to the west coast. Minor indentations in the cliff such as The Vomit and Hook Vale funnel winds up the cliff face on the west. Deep cut valleys lead down to Mill Bay and Watwick Bay in the south. Other valleys such as those to Castlebeach Bay as well as the more open trough of Dale Valley (Groom, 1956) are oriented to face due east. Haygardhay Valley provides a south to north incision in the centre of the parish which opens out to the north of Moorland's Cottage. The prevailing wind blows either at right angles to these valleys or is diverted along them. Winds with a westerly component sweep across the sheltered Haygardhay Wood which is one of the few localities where tall trees can grow. These trees are levelled off at the valley top in a quite spectacular fashion. Dale Valley is much more open to such winds which tend to be canalized down the valley. Their shaping effect is clearly apparent in the profile of Blue Anchor Wood where the height of the trees increases eastward, and in the windswept woodland around Dale Castle. The wood at the head of Castlebeach Valley has a similar wedge-shaped profile with the apex facing west. The valleys give varying degrees of shelter as compared with the plateau top and cliff-edges. This was strikingly illustrated by a four-day period of wind speed measurements using portable air-meters carried out with the help of geography students from the University College of Swansea. The measurement of wind speeds and directions confirmed the evidence of the vegetation.

In addition to its effect upon tree distribution, the shaping effect of the wind is clearly imprinted upon the form of the hawthorn and other hedgerow bushes. A detailed study of the orientation of the wind-shaped bushes based upon compass readings revealed some interesting data. The shaping wind in the south of the parish is more south-westerly while that towards the centre and north has a more W.S.W. component. The wind records at St. Ann's Head and Dale Fort showed a well-marked tendency for many winds to back at the latter place. This same tendency was observed when comparing the Dale Fort and Kete records. On the south and east cliff-faces the bushes are swept by up-cliff winds blowing at right angles to the coast. Along the valleys leading down to Mill Bay and to Watwick Bay bushes on and near the valley floor show a prevalent wind from the S.S.E. but bushes higher up the valley sides near to the plateau surface are shaped by the south-west to W.S.W. winds. Towards the head of such valleys there is a complex interaction of the main air stream lines across the peninsula and the up-valley wind.

In late spring and early summer, especially, sea breezes may occur, developing at various times between 11 and 13 G.M.T. (Thomas, 1956). They vary in direction from more north-west winds in the north of the peninsula to more south-westerly in the south. In Dale parish, however, they are not a very noticeable feature since their influence is not easy to distinguish from the normal wind directions. They modify the gradient wind rather than produce a day and night reversal of direction. A study of hourly wind observations at Kete during the summer revealed a tendency on favourable days for the winds of the late morning and early afternoon to change towards the south-west or west-south-west.

The effects of the physical damage and drying effect of the winds are increased by the salt spray swept over the whole of the peninsula. A major opportunity for investigation would be a quantitative assessment of the significance of salt spray. The scorched growing tips of the pasture grasses and the frayed haulms of the new potatoes, after strong winds, underline the farmer's concern with this feature of the local climate. Fields differ in the degree to which they are affected but only subjective impressions can be formed. Fields near the cliffs are often protected by the eddy developing over the cliff-edge whilst damage further inland can be more severe.

Regional variations in humidity have been analysed within the limitations of the records. A comparison between Kete and Dale Fort revealed that the relative humidity readings were lower at Dale Fort in 61·3 per cent of the observations. Dale Fort had negative deviations of 5 per cent or more in 24·2 per cent of the cases and only 4·8 per cent of its relative humidities exceeded those at Kete by 5 per cent or more. The temperature differences between the two stations do not explain the contrasts noted. A comparison between the hygrograph charts for Brunt Farm and Upper Dale Hill showed both to have high relative humidities, with the more inland site at Upper Dale Hill having somewhat lower values.

The study of local climatic differences in the peninsula offers innumerable opportunities for investigations in the field both of short and long duration. There are many problems of instrumentation especially when the differences are of relatively small magnitude but some rewarding results can be expected.

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