

THE SPEED AND ALTITUDE OF BIRD FLIGHT (WITH NOTES ON OTHER ANIMALS).

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BIRD SPEEDS.

In 1921 I published some preliminary remarks on the velocity of bird flight; since then, a large number of scattered notes have appeared in various publications recording bird speed in flight. The more important of these will be found in a bibliography at the end of this paper; the other records, over 200 in number, are referred to by reference number, the original source being available for anyone interested. I have omitted many records based on guesswork or on inaccurate calculations.

In 1921 I thought that the speed attained by birds when on migration was not greater than normal cruising speed. Harrison (1931) quite rightly questioned this and I am now convinced that I was wrong. In most cases migratory speed is greater than normal flight, as can be seen from many cases quoted in Table A. But there are exceptions. My experience of Accipitrine migration is that they dawdle when on passage, even the falcons not exceeding normal cruising rate; the same can be said of the Laridae or gulls. But among nearly all other groups, migratory flight exceeds normal speed and is best equalled by "going-to-roost" speed; local movement for food is never so fast as flying with a purpose, hurrying to get somewhere.

It would appear that homing pigeons use "migration" speed. Their velocity naturally depends on wind, distance, and may be affected by stimulants, flying under the jealousy and widowhood systems, or when breeding and incubating. When racing they appear to start fast on release, then go slower, then cover the main flight in spurts of fast and slow speeds which tend to break up the flock. Other incentives to high speeds are instanced in Table A by the House Martin, Blackbird, Thrush and Swallow, all acting under the stimulus of parenthood.

Many birds use maximum speeds in courtship flight such as the Lapwing or when playing in crazy flight such as Swifts and many Swallows.

Another interesting fact emerges from Table A. Many birds, even when frightened or pressed by a motor car, do not appear to be able to attain maximum migration speed. Donald (73) found that Indian Crows, whose normal cruising rate is about 25 m.p.h. when near trees, accelerate to 30 and 35 m.p.h. in open country where there is a risk of attack by predators.

All birds, except heavy birds with small wing-areas such as auks, divers, grebes, Capercaillie etc., have a big reserve speed, some species being able almost to double their normal cruising speed. In the same way as aircraft can increase speed by increased revolutions of the propeller, so birds increase speed by more rapid flapping of wings. This can be seen from Table B.

It is my experience that birds in flock tend to fly faster than when in a looser formation. I have noticed this especially among larks and swallows, whether on migration or moving feeding grounds.

A problem in bird flight which has long puzzled me and which has never been explained, is how a bird can fly against a wind whose velocity is greater than the bird's maximum speed. An Eider Duck's maximum speed in calm weather is about 50 m.p.h. In theory, if a bird flying at 50 m.p.h. meets a wind greater than its maximum speed, its ground-speed becomes a minus quantity; and yet in practice that is not the case.

I was in South Uist during a gale which registered 80-90 m.p.h. with gusts up to 95 m.p.h. at a local anemometer twenty feet from the ground. It is known that a great reduction in wind speed occurs as ground level is reached, but a difference of twenty feet could scarcely reduce 80 m.p.h. to 50 m.p.h. and less. This particular wind was so strong that shooting was out of the question, wild swans were grounded and unable to rise and we experienced the greatest difficulty in walking against it. Eider Duck had come inland from the sea and were sitting about on the short grass. When disturbed they would rise into the wind and make headway against it at ground level, doing about 15-20 m.p.h., except for one bird who actually achieved a minus ground-speed and slowly backed towards us.

I have also seen Rooks and gulls flying into a wind far exceeding their maximum speeds and doing it with ease though not making much headway. Their flight was not direct but with considerable "putting your nose down". There is also a case of a flock of Wood-pigeon (144) flying into a wind recorded as 110 m.p.h. which "blew down 200-year-old trees like ninepins". The pigeons were progressing at about 40 m.p.h. instead of backwards if theory is correct. I am convinced that birds of strong flight can and do make headway against a wind exceeding their maximum speed. How is it done?

What is the maximum speed of a bird in flight? With the assistance of gravity or a tail wind, speed of well over a hundred miles an hour can be attained; but in calm weather and without gravity assistance, the fastest birds listed in Table A are: Homing Pigeon 94.3 and 82 m.p.h., Golden Plover 62, Hummingbird 60, Mallard 60, Swift 57. It is very doubtful if any falcon in level flight can touch 60 m.p.h., though of course when stooping this speed is greatly exceeded.

It was found by the Air Ministry Pigeon Section 1940-1946 that a Peregrine Falcon could not kill a racing pigeon unless either the pigeon was tired after a long distance flight or unless the hawk was "waiting on". Racing

pigeons will often fly low and these of course are easy prey for a high-perched falcon. I am also convinced that a falcon can rarely overtake a sandgrouse in level chase.

There are many ways by which the speed of a bird in flight can be obtained. Unless the speed of the wind can be ascertained, all tests had better be made in calm or almost calm weather; it must also be remembered that even though calm at ground level there may be considerable wind one hundred feet up.

The most reliable method of obtaining flight speed is on a measured base with competent people using theodolites at each end of the base. Small rangefinders used with clinometers come near in efficiency. These methods were largely used by me during the First World War.

The usual method of estimating the speed of a bird in flight is by car speedometer; if used with accurate instruments it is reliable; speeds can also be obtained from a train whose rate can be ascertained by the quarter-mile pegs on the track.

One can obtain great accuracy with two people with stop-watches at each end of a measured base which should be at least 100 yards long; this method is best used at places where birds can be expected to fly past either when moving feeding grounds owing to tide movement or when going to roost. It is difficult for a single person to obtain flight speeds though it can be done by timing birds with a stop-watch when flying from tree to tree or when taking off from the ground to settling, allowing ten yards at each end for acceleration and slowing-down.

I have included several records taken by airmen when flying. During the First World War when some machines were incapable of more than 60 miles an hour, such records were fairly reliable, but to-day when few machines fly at under 200 m.p.h. such records can only be unreliable.

ALTITUDE OF BIRD FLIGHT.

I have omitted from these notes all records of the altitude of flight obtained through telescopes of birds crossing the moon by night. Calculations based on these observations must have too great a margin of error to render them reliable. In some cases even the species has been identified at 14,000 feet; that alone made me suspicious of moonshine records.

Views on altitude of flight show great diversity and this reflects the facts. What regulates height of migratory movement is not clear. In some cases it may be to locate familiar land-marks, or to fly in the least wind-resistance or to gain height from a head wind to a tail wind. In most cases fog or cloud will bring birds down, but in some cases, among birds of powerful flight, it causes ascent, sometimes above cloud level. Or, in the case of mountain barriers, height is gained to pass a physical obstacle.

Among the smaller passerines, whether on land or sea, migration takes place almost always under 200 feet, in rough weather usually much lower. My experience in the desert is that birds fly very close to the ground. I have seen Turtle Doves, larks and Hoopoes migrating at barely a foot above ground level. On the other hand there is the remarkable record of " Linnet-like birds " at 10,000 feet over France in August (A. 54).

Among larger birds, altitude is more variable, depending mainly on weather conditions; though I have seen kites *Milvus* migrating at ground level and at over 5000 feet at the same time and place. I have also seen Fieldfares, Redwings and Blackbirds arriving in Fair Isle from the north during a violent south-east gale, many birds at wave height and others out of gunshot distance.

Gätke considered migratory movement to take place normally beyond human vision. Landsborough Thomson (1926) has shown this to be unfounded. Whitlock (1897) also shows up the fallacies of Gätke's arguments and the entire lack of evidence in support of his theory. But, nevertheless, there is a growing volume of evidence to show that migratory movement does sometimes extend to extremely high altitudes though this is not the rule; the reason for those exceptions which have been recorded is not obvious.

Meteorological conditions are probably responsible for all high-altitude migration, except when passage extends over a physical obstacle like the Himalayas. Wind at ground level may have half the velocity of the same wind at 100 feet above ground level and a southerly wind at ground level may turn to a northerly wind at 5000 feet.

Human estimates of altitude are unreliable. Lucanus (1911) experimented on the visibility of birds at various heights. A Sparrowhawk could be distinguished at 800 feet but disappeared from human vision at 2800 feet. A Rook could be recognized at 1000 feet but disappeared from view at 3300 feet. The following experiment was carried out by the R.A.F. in Iraq at my request in 1923. An inflated model of a vulture released from an aeroplane was barely visible at 4700 feet and invisible without binoculars at 5800 feet. At 7000 feet it was not picked up even when using $\times 12$ binoculars. The model was coloured black and had a wing expanse of 2390 mm.

It may be noted in conclusion that many published records of velocity and altitude of birds are pure fancy, though claiming to be based on reliable calculation. Such are Gätke's records of Hooded Crows flying at 100 m.p.h. and Bluethroats at 180. The famous Roubaix Swallow (22) had a speed of 106 m.p.h. and another Swallow (69) of 150. Stuart Baker (6) recorded a swift (*Chaetura*) flying at 200 m.p.h. and Fraser Darling (86) a Golden Eagle attaining 100 m.p.h. while gaining 1000 feet of height. Gannets (23) have been recorded as flying at 120 m.p.h. on the level, a Frigate Bird (87)

at 244 m.p.h. over the Indian Ocean, Green Plover (39) at between 120 and 165 m.p.h., Godwits (42) at 150 and a Curlew (2) at 240. Among altitude records I suspect that of swifts sleeping under the full moon over the Vosges at 9000 feet (18).

I have in my possession a photograph of the sun taken at noon at Dehra Dun in India on 17 Sept. 1919. Crossing the sun is a skein of 17 geese. Basing a calculation on the known diameter of the sun and the probable expanse of a goose's wing when in flight, it has been estimated (27) that these geese were at between eleven and twelve miles high. Another estimate is that their height is about five miles. But the lack of clear definition of both sun and geese is so great that no satisfactory solution is possible and it is better to discard the record.

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TABLE A. *Velocity of bird flight.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
R.M.	Raven	Scotland	32-35	Stop-watch. Flying to roost.
79	<i>Corvus corax</i>	California	24	Speedometer.
R.M.	do.	Morocco	28-33	Speedometer. Cruising.
R.M.	do.	Palestine	32-39.5	Instrument. Flying to roost.
R.M.	do.	Palestine	21-23	Speedometer. Cruising.
31	Carrion Crow	Silesia	29	Stop-watch : 12 counts, average.
66	<i>Corvus corone</i>	U.K.	20-32	Speedometer.
50	do.	Germany	31.2	Instrument. Migrating.
54	do.	Germany	31.5	Instrument : average of 20 counts. Migrating.
45	"Crows"	India	22	Speedometer. Flying to roost.
73	do.	India	25-35	Speedometer : 2 counts. Cruising and maximum.
105	Eastern Crow	U.S.A.	26	Speedometer.
145	<i>Corvus brachyrhynchus</i>			
	Rook	Germany	29-42	Rangefinder : 15 counts. Slight head wind.
	<i>Corvus frugilegus</i>			

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
50	Rook	Germany	32.6	Instrument.
144 a	<i>Corvus frugilegus</i> do.	U.K.	24-35	Migrating. Speedometer : 8 counts. From easy flight to deliberate.
66	do.	U.K.	37-35	Speedometer.
R.M.	do.	France	38-39.25	Instrument : 4 counts. Migrating.
R.M.	do.	France	45	Instrument.
65	do.	U.K.	35	Migrating.
50	Jackdaw	Germany	39.6	Speedometer.
R.M.	<i>Corvus monedula</i> do.	France	40	Instrument : average of several counts.
65	do.	U.K.	30	Instrument.
144 a	do.	U.K.	30-36.5	Migrating. Speedometer.
R.M.	do.	Palestine	55-57	Speedometer : 9 counts. Normal flight.
50	do.	Germany	38.4	Speedometer : 2 counts. Migrating.
66	Magpie	U.K.	23-28	Instrument.
144 a	<i>Pica pica</i> do.	U.K.	19	Migrating. Speedometer : 3 counts. Going to roost.
79	Blue Jay	New England	20	Speedometer.
R.M.	<i>Cyanocitta cristata</i> Chough	Baluchistan	11.5	Speedometer. Leisurely from tree to tree.
37	<i>Pyrhocorax</i> <i>pyrrhocorax</i>	U.S.A.	26	Speedometer.
79	Baltimore Oriole	Kansas	12	Speedometer.
79	<i>Icterus galbula</i> do.	New Hampshire	26	Speedometer.
37	Grackle	U.S.A.	27	Speedometer.
79	<i>Quiscalus quiscula</i> do.	New Hampshire	27, 30	Speedometer : 2 counts.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
83	Grackle <i>Quiscalus quiscula</i>	U.S.A.	20–28	Speedometer : 8 counts.
79	Meadow Lark <i>Sturnella</i>	Kansas	20	?
83	do.	U.S.A.	15, 20, 20	Speedometer : 3 counts.
83	Red-winged Blackbird <i>Agelaius phoeniceus</i>	U.S.A.	22, 23, 23	Speedometer : 3 counts.
83	Rusty Blackbird <i>Euphagus carolinus</i>	U.S.A.	19, 19, 20, 23	Speedometer : 4 counts.
R.M.	Rosy Pastor <i>Sturnus roseus</i>	Baluchistan	38–40·5	Stop-watch : 4 counts.
R.M.	do.	Afghanistan	44–46	Stop-watch. Migrating. Slight side-wind.
R.M. and 65	Starling <i>Sturnus vulgaris</i>	U.K.	26, 27, 32	Speedometer. Pressed.
9, 66, 78	do.	U.K.	23–32	Speedometer 17 counts. Cruising.
R.M.	do.	Palestine	45–48·5	Theodolite : 22 counts. Flying to roost.
R.M.	do.	Baluchistan	43–49	Stop-watch : 13 counts. Migrating.
50, 54	do.	Germany	46, 3–46, 5	Instruments : 3 counts. Migrating.
R.M.	do.	U.K.	41–48	Speedometer : 3 counts. Flying to roost.
73	do.	India	over 45	Speedometer. “Cruising”, but probably flying to roost.
R.M.	do.	Hampshire	48·1–50·4	Stop-watch : 7 counts on birds taken from brooding and flying back to nest.
R.M., 102	do.	U.S.A.	28, 35, 51·4, 55	Speedometer. Cruising.
144 a	do.	U.K.	25–30·5	7 counts. Cruising to fast.
R.M.	Hawfinch <i>Coccothraustes</i>	U.K.	37, 39	Stop-watch. Tree to tree, a frightened bird.

TABLE A.—Continued.

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
R.M. and 144 a	Greenfinch <i>Chloris chloris</i>	U.K.	23, 35, 36	Speedometer : 3 counts.
144 a	Goldfinch <i>Carduelis carduelis</i>	U.K.	26	Speedometer. Normal flight.
R.M.	Linnet <i>Carduelis cannabina</i>	Iraq	23, 25	Speedometer : 2 counts. Cruising in flock.
144 a	do.	U.K.	26-36	Speedometer : 7 counts. Higher speed when hurried.
R.M.	Lesser Redpoll <i>Carduelis linaria</i>	Ireland	19, 22	Stop-watch : 2 counts. Tree to tree, leisurely.
50	Siskin <i>Carduelis spinus</i>	Germany	34-38	Instrument. Migrating in flock.
50	Crossbill <i>Loxia curvirostra</i>	Germany	37.1, 37.5	Instrument. Migrating.
50	Chaffinch <i>Fringilla coelebs</i>	Germany	32.8	Instrument. Migrating in flock.
66	do.	U.K.	27-35	Speedometer : 3 counts when pressed by car.
R.M.	do.	U.K.	21, 22, 21	Speedometer : 3 counts. Normal flight.
144 a	do.	U.K.	25-29	Speedometer : 3 counts.
R.M.	Bramble Finch <i>Fringilla montifringilla</i>	U.K.	30.2	Stop-watch. Large flock from tree to tree over 220 yards.
83	House Sparrow <i>Passer domesticus</i>	U.S.A.	28, 35	Speedometer. Pressed.
9	do.	U.K.	24	Speedometer.
R.M.	do.	Kashmir	33-35	Stop-watch : 3 counts of migrating flocks.
144 a	do.	U.K.	32, 33	Speedometer : 2 counts.
144 a	Common Bunting <i>Emberiza calandra</i>	U.K.	34	Speedometer. Pressed.
R.M.	do.	Palestine	29.5	Stop-watch. Flock flying to water.
12, 65, 66	Yellow Hammer <i>Emberiza citrinella</i>	U.K.	22, 28, 30	Speedometer. Normal flight.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
144 a	Yellow Hammer <i>Emberiza citrinella</i>	U.K.	26–35	Speedometer. Normal flight to alarmed.
36	Snow Bunting <i>Plectrophenax nivalis</i>	North Atlantic	16.5	Migrating. Estimated from ship's speed.
79	Indigo Bunting <i>Passerina cyanea</i>	New Hampshire	20	Speedometer.
79	Savannah Sparrow <i>Passerculus sandwichensis</i>	California	37–42	Speedometer : several counts.
76	Vesper Sparrow <i>Poocetes gramineus</i>	New Hampshire	17	Speedometer.
37, 79	Song Sparrow <i>Melospiza melodia</i>	U.S.A.	17	Speedometer : 2 counts.
83	Junco <i>Junco hyemalis</i>	U.S.A.	18	Speedometer.
76	Chipping Sparrow <i>Spizella passerina</i>	New Hampshire	15, 15, 20	Speedometer : 3 counts.
79, 83	Kingbird <i>Tyrannus tyrannus</i>	U.S.A.	11, 15	Speedometer : 2 counts.
79	Arkansas Kingbird <i>Tyrannus verticalis</i>	Kansas	17	Speedometer.
79	Scissor-tailed Flycatcher <i>Muscivora forficata</i>	Kansas	10	Speedometer.
R.M.	Calandra Lark <i>Melanocorypha calandra</i>	Palestine	27–34	Stop-watch : 3 counts. Fast cruising.
R.M.	do.	Palestine	35, 36	Stop-watch and speedometer. Flocks coming to water.
R.M.	Crested Lark <i>Galerida cristata</i>	Iraq	22, 23	Speedometer : 2 counts. Leisurely flight.
R.M.	do.	Arabia	34	Speedometer. Migrating in flock.
R.M.	Desert Lark <i>Ammomanes deserti</i>	Morocco	18	Speedometer. Maximum speed before car.
66	Skylark <i>Alauda arvensis</i>	U.K.	22–28	Speedometer : 3 counts.
R.M.	do.	Arabia	33–37	Speedometer : 3 counts. Migrating.
79	Horned Lark <i>Eremophila alpestris</i>	California	17–54	Speedometer : 10 counts.

TABLE A.—Continued.

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
R.M.	Meadow Pipit <i>Anthus pratensis</i>	Hampshire	20.3	Stop-watch. Timed over 64 yards.
R.M.	"Pipits"	U.K.	20	Speedometer.
R.M.	Red-throated Pipit <i>Anthus cervinus</i>	Kenya	26.5	Theodolite.
R.M.	do.	Palestine	20, 25	Migrating flock. Stop-watch. Two flocks coming to water.
R.M.	Yellow Wagtail <i>Motacilla flava</i>	Kenya	29, 30.1	Theodolite.
144 a	do.	U.K.	22.5	Migrating flocks. Speedometer.
66	Grey Wagtail <i>Motacilla cinerea</i>	U.K.	28	Normal flight. Speedometer.
9, 49	Pied Wagtail <i>Motacilla alba</i>	U.K.	21, 25	Easy flight. Stop-watch : 2 counts. Flight over 240 yards.
R.M.	do.	U.K.	17.6	Stop-watch. Timed over 94 yards, slightly upward flight.
144 a	do.	U.K.	25	Speedometer.
R.M.	White Wagtail <i>Motacilla alba</i>	Ireland	20-24	Stop-watch. Migrating.
82	Indian Pied Wagtail <i>Motacilla maderaspatensis</i>	India	25	15 m.p.h. head wind. Speedometer.
R.M.	Nuthatch <i>Sitta europaea</i>	Hampshire	18.4	Stop-watch. Tree to tree over 48 yards.
R.M.	Blue Tit <i>Parus caeruleus</i>	U.K.	21	Stop-watch. Over 40 yards distance from tree to tree.
8	Willow Wren <i>Phylloscopus trochilus</i>	U.K.	23.5	Speedometer. Pressed by car.
R.M.	do.	U.K.	27	Speedometer. Twist-ing flight before car.
79	Cat Bird <i>Dumetella carolinensis</i>	New England	16	Speedometer.
83	do.	U.S.A.	12	Speedometer.
83	Brown Thrasher <i>Toxostomus rufus</i>	U.S.A.	19, 22	Speedometer : 2 counts.
23	Missel Thrush <i>Turdus viscivorus</i>	U.K.	23	Speedometer. Normal flight.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
144 a	Missel Thrush <i>Turdus viscivorus</i>	U.K.	35	Speedometer. Pressed.
R.M., 66, 97	Song Thrush <i>Turdus philomelos</i>	U.K.	27-30	Speedometer : 3 counts.
R.M.	do.	Hampshire	30.2-31.6	Stop-watch : 2 counts on birds flying back to nest after being taken from brooding.
144 a	do.	U.K.	30.5	Speedometer. Pressed.
37, 79, 83	American Robin <i>Turdus migratorius</i>	U.S.A.	17-32	Speedometer : 9 counts.
R.M., 9, 65, 66	Blackbird <i>Turdus merula</i>	U.K.	22-33	Speedometer : 14 counts.
144 a	do.	U.K.	29, 30	Speedometer. Alarmed.
9	do.	U.K.	18	Stop-watch : im- mature bird timed over 149 yards.
R.M.	do.	Hampshire	29.1-30.4	Stop-watch : 3 counts on birds flying back to nest after being taken from brooding.
144 a	Fieldfare <i>Turdus pilaris</i>	U.K.	31, 31.5	Speedometer : 2 counts, one in flock.
79, 83	Bluebird <i>Sialia</i> sp.	U.S.A.	13, 15, 17, 26	Speedometer.
R.M., 66	Wheatear <i>Oenanthe oenanthe</i>	U.K.	18, 32	Speedometer.
R.M.	do.	Ireland	17-23	Stop-watch. Migra- ting. 15 m.p.h. head wind.
144 a	do.	U.K.	35-38	Speedometer. Flitting over distances 50 to 100 yards.
R.M.	Wren <i>Troglodytes</i>	Scotland	18-22	Speedometer : 6 counts.
R.M.	Hedge Sparrow <i>Prunella modularis</i>	U.K.	14.2	Stop-watch. Leisurely flight over 106 yards.
48, 66, 108	Swallow <i>Hirundo rustica</i>	U.K.	25-27	Speedometer : 5 counts when feeding.
144 a	do.	U.K.	23-32	Speedometer : 11 counts, mostly feed- ing, higher speeds when travelling.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
66	Swallow	U.K.	38	Speedometer.
R.M.	<i>Hirundo rustica</i>			A frightened bird.
	do.	Germany	22-24	Speedometer :
R.M.	do.	Kenya	37.75	7 counts when feeding.
R.M.	do.	Kenya	34	Theodolite; migrating.
R.M.	do.	Ireland	21-23	Theodolite; migrating, strong head wind.
R.M.	do.	Hampshire	35.4-36.5	Stop-watch. Migrating. 15 m.p.h. head wind.
121	do.	S. Africa	30-36	Stop-watch : 2 counts on birds flying back to nest after being taken from brooding.
79	do.	U.S.A.	20, 20, 44-46	Speedometer. Normal flight.
R.M.	Red-rumped Swallow	Palestine	36-37.75	Speedometer. Normal flight. Higher speeds probably exaggerated.
66	<i>Hirundo daurica</i>			Stop-watch.
R.M.	House Martin	U.K.	25, 29, 30,	Migrating.
144 a	<i>Delichon urbica</i>		46	Speedometer.
	do.	U.K.	24	Normal flight.
144 a	do.	U.K.	27	Speedometer.
68	do.	Ireland	50	Normal flight.
79	Sand Martin	U.K.	31	Migrating.
144 a	<i>Riparia riparia</i>			Stop-watch. Parent, returning to nest after being taken from it and released 10 miles away.
	do.	U.K.	31	Speedometer.
83	Purple Martin	U.S.A.	20	Chased by car.
83	<i>Progne subis</i>			Speedometer.
41	Tree Swallow	U.S.A.	25	Speedometer.
	<i>Iridoprocne bicolor</i>			
	Swift	Iraq	over 68	Speedometer.
R.M.	<i>Apus apus</i>			Airspeed Indicator.
	do.	U.K.	38, 42	Can only be guess-work.
				Speedometer. Normal feeding flight.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground Speed m.p.h.	Method of measurement and remarks
R.M.	Swift <i>Apus apus</i>	Paris	54, 57	Stop-watch over 130 yards distance when whirling in noisy flock.
191 b	do.	London to Tournai	37.5	Homing experiment in four hours.
191 d	do.	Holland	37.5, 62.5	Lower speed normal, higher by acceleration.
79	Ruby-throated Humming Bird <i>Archilochus colubris</i>	Pennsylvania	45	Speedometer. 200 yards easy flight.
85, 125	do.	U.S.A.	50, 55-60	Speedometer. Normal flight.
83	Eastern Nighthawk <i>Chordeiles minor</i>	U.S.A.	12, 17, 22	Speedometer.
R.M.	Roller <i>Coracias garrulus</i>	Kenya	38.7	Theodolite.
61, 73	Pied Kingfisher <i>Ceryle rudis</i>	India	31, 32	Speedometer : 2 counts.
83	Belted Kingfisher <i>Megaceryle alcyon</i>	U.S.A.	17	Speedometer.
45	Green Parrot <i>Psittacula krameri</i>	India	26	Speedometer. Normal flight.
R.M.	do.	India	32.2	Stop-watch. Flying to roost.
79	Flicker <i>Colaptes cafer</i>	U.S.A.	20-25	Speedometer : 3 counts.
79	do.	U.S.A.	43, 44	Speedometer. Slightly startled.
37, 83	Northern Flicker <i>Colaptes auratus</i>	U.S.A.	23, 25	Speedometer : 2 counts.
83	Red-headed Woodpecker <i>Melanerpes erythrocephalus</i>	U.S.A.	22	Speedometer.
R.M.	Green Woodpecker <i>Picus viridis</i>	U.K.	23	Speedometer. Chased by car.
R.M.	Pied Woodpecker <i>Dendrocopos major</i>	U.K.	19.5	Speedometer. Maximum speed with undulating flight.
23, 49, R.M.	Cuckoo <i>Cuculus canorus</i>	U.K.	23, 23, 24	Speedometer. Normal flight.
144 a	do.	U.K.	27	Speedometer. Pressed.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
83	Yellow-billed Cuckoo <i>Coccyzus americanus</i>	U.S.A.	22	Speedometer.
144 a	Tawny Owl <i>Strix aluco</i>	U.K.	40-45	Speedometer. At dusk.
50	Peregrine <i>Falco peregrinus</i>	Germany	37	Instrument. Migrating.
79	do.	U.S.A.	165-180	Stop-watch. Hunting. Almost certainly exaggerated unless stooping.
79	do.	U.K.	62	Speedometer. Level cruising.
R.M.	do.	Sudan	48-49	Trained tiercel in level chase after sand-grouse. Stop-watch and measured distance.
R.M.	Lanner Falcon <i>Falco biarmicus</i>	Palestine	48	Stop-watch. Hunting but not in pursuit.
R.M.	Merlin <i>Falco columbarius</i>	Scotland	34, 36	Speedometer. Cruising.
R.M.	Kestrel <i>Falco tinnunculus</i>	Kenya	22, 40.5, 43.9	Theodolite. Migrating. Strong head wind for the 22 m.p.h.
144 a	do.	U.K.	36-38	Speedometer. Pressed.
47	do.	U.K.	18-19	Speedometer. Normal.
79	Red-tailed Hawk <i>Buteo borealis</i>	California	22	Speedometer. Cruising.
79	Swainson's Hawk <i>Buteo swainsoni</i>	Kansas	15	Speedometer. Cruising.
50	Sparrowhawk <i>Accipiter nisus</i>	Germany	25.8	Instrument. Migrating.
R.M.	Marsh Harrier. <i>Circus aeruginosus</i>	Baluchistan	31, 36	Stop-watch. Cruising. Calm and slight head wind.
R.M.	do.	Palestine	37.5	Stop-watch. Hunting.
R.M.	Lammergeier <i>Gypaetus barbatus</i>	Baluchistan	79.5	Stop-watch. Gliding to food at 12 degrees to horizontal. Strong side wind.
56	do.	Italy	110	Airspeed Indicator. Diving to avoid plane. Accuracy doubtful.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
45	" Vulture "	India	50	Instrument. Slightly gliding.
73	White-backed Vulture <i>Pseudogyps bengalensis</i>	India	47	Speedometer. Level gliding and bird heavily gorged.
79	Turkey Vulture <i>Cathartes aura</i>	Missouri	21	Checked by pace of train; cruising, flapping flight.
83	do.	U.S.A.	15	Speedometer. Level flight.
121	Griffon Vulture <i>Gyps coprotheres</i>	S. Africa	42	Speedometer. Cruising.
41	White Stork <i>Ciconia ciconia</i>	Iraq	48	Airspeed indicator. Migrating. Accuracy doubtful.
65	Grey Heron <i>Ardea cinerea</i>	U.K.	28	Speedometer. Cruising.
144 a	do.	U.K.	24-25	Speedometer. Slow flight.
79, 116	Great Blue Heron <i>Ardea herodias</i>	U.S.A.	19-28	Speedometer : 5 counts.
83	American Egret <i>Ardea alba</i>	U.S.A.	17	Speedometer. Cruising.
119	Little Egret <i>Egretta garzetta</i>	Palestine	20-25	Speedometer. Cruising.
83	Eastern Green Heron <i>Butorides virescens</i>	U.S.A.	22	Speedometer. Cruising.
74	Whistling Swan <i>Cygnus columbianus</i>	U.S.A.	50-55	Airspeed indicator. Maximum speed. Doubtful accuracy.
R.M.	Bewick's Swan <i>Cygnus bewicki</i>	U.K.	39-42	Stop-watch : 4 counts. Normal flight.
94, 104, 112	Mute Swan <i>Cygnus olor</i>	U.K.	31, 37, 38, 40	Speedometer : 5 counts. Cruising.
R.M.	Whooper Swan <i>Cygnus cygnus</i>	U.K.	41, 43, 44.	Stop-watch : 3 counts. Cruising.
20, 41, R.M., 56, 72	" Geese " <i>Anser</i> sp.	Iraq, U.K., France	25, 44-56	Theodolite and air-speed indicator. Higher speeds when chased by plane; probably guesswork.
110	do.	North Sea	25, 33-35	Radar. Migrating. Tail wind
174	do.	U.S.A.	44-3	Theodolite. Migrating.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
79	Snow Goose <i>Anser hyperboreus</i>	California	50	Airspeed indicator. Accuracy doubtful.
1	Brent Goose <i>Branta bernicla</i>	U.K.	45	Airspeed indicator. On passage; accuracy doubtful.
50, 56, 72, 79 168	Mallard <i>Anas platyrhynchos</i> do.	Europe and America U.S.A.	46-70 46-60	Airspeed indicator. Accuracy doubtful. Stop-watch. Migrating.
174	" Duck "	U.S.A.	47.9	Theodolite. Migrating.
79, 168	Pintail <i>Anas acuta</i> do.	California Sudan	52-65 37-51	Airspeed indicator. Of doubtful accuracy. Stop-watch: 7 counts. Migrating.
83	Black Duck <i>Anas rubripes</i>	U.S.A.	26	Speedometer. Normal flight.
84	Teal <i>Anas crecca</i> do.	U.K. Palestine	67-70 44	Airspeed indicator. Of doubtful accuracy. Stop-watch. Normal level flight.
79	Shoveler <i>Spatula clypeata</i>	California	47, 53	Speedometer. Easy flight.
79	Canvasback Duck <i>Aythya valisineria</i>	U.S.A.	72	Airspeed indicator. Of doubtful accuracy.
79	Goldeneye <i>Bucephala clangula</i>	U.S.A.	under 50	Checked by train speed.
111	Long-tailed Duck <i>Clangula hyemalis</i>	Canada	54-72	Instrument : 12 counts. Tail wind.
R.M.	Pelican <i>Pelecanus onochrotalus</i>	Palestine	51	Stop-watch. Migrating at 1240 feet in flock. Slight side wind.
79	Brown Pelican <i>Pelecanus occidentalis</i>	Florida	26	Speedometer ; four birds over distance of over eight miles.
81, 123	White Pelican <i>Pelecanus erythrorhynchos</i>	U.S.A.	30, 31	Speedometer : 2 counts on cruising flocks.
56	Gannet <i>Sula bassana</i> do.	France Florida	48 25	Instrument. Cruising. Speedometer; 4 birds. Head wind.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
66	Cormorant <i>Phalacrocorax carbo</i>	U.K.	27, 35	Speedometer. Higher speed is of frightened bird.
25	do.	U.K.	45	Speedometer. Slight tail wind.
90	do.	Leicester	60–70	Airspeed indicator. Migrating. Accuracy doubtful.
79	Cormorant <i>Phalacrocorax</i> sp.	Florida	20	Speedometer, 4 birds. Head wind.
136	Great Northern Diver <i>Colymbus immer</i>	U.S.A.	62	Speedometer. Timed over five miles.
196	do.	U.S.A.	90	Airspeed indicator : bird in shallow dive.
145	Woodpigeon <i>Columba palumbus</i>	Germany	33–54	Rangefinder : 11 counts. Slight side wind.
144 a	do.	U.K.	50, 51	Speedometer. Hard pressed.
144 a	do.	U.K.	41, 43	Speedometer. Normal flight.
65, 66	do.	U.K.	38–51	Speedometer. Bird pressed at higher speed.
R.M.	Stock Dove <i>Columba oenas</i>	Palestine	42·25	Stop-watch. Flock coming to water.
144 a	do.	U.K.	59	Speedometer. Bird hard pressed.
R.M.	Rock Pigeon <i>Columba livia</i>	South Uist	47	Stop-watch. Flock flying to evening roost.
177	<p>Homing Pigeons. <i>Note.</i>—Speed depends on the direction of the wind, and may be affected by the use of stimulants, or flying under the jealousy and widowhood systems, or when breeding or incubating. Velocity does not allow for time circling at liberation or trapping. Pigeons appear to start fast on release, then go slower, then cover the main flight in spurts of fast and slow speeds which tend to break up the flock.</p> <p>Averages :</p> <p>30–35 m.p.h. against wind, birds flying low.</p> <p>40–45 m.p.h. with side wind.</p> <p>60 m.p.h. or more with tail wind, birds flying high.</p> <p>There are several records of over 90 m.p.h. over courses of 80 miles. 182 miles have been covered at 73 m.p.h. In Canada a bird covered 740 miles from Winnipeg to Alberta at a rate of 47·2 m.p.h.</p>			

TABLE A.—Continued.

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
18	Homing Pigeon	U.K.	27.9	Stop-watch over known distance. Bird not homing.
21	do.	U.K.	54, 57, 62, 71	Homing over distances varying from 50 to 215 miles.
70	do.	Europe	52-82	Homing over distances varying from 80 to 600 miles.
35	do.	France	60	A single bird chased by plane, the latter's maximum speed being 60.
80	do.	U.S.A.	37-74	Homing over distances varying from 100 to 650 miles.
10	do.	U.K.	80	Tail wind over distance of 80 miles.
77	do.	U.K.	94.3	Highest recorded speed in 1933.
151	do.	U.K.	27 33	In covered gallery. In open.
R.M.	Green Pigeon	India	29-30	Speedometer.
	<i>Crocopus</i> sp.			Normal flight.
R.M.	Green Pigeon	Aden	34	Stop-watch. From tree to tree over 420 yards.
	<i>Treron waalia</i>			
R.M.	Turtle Dove	Sinai	37	Checked by train speed.
	<i>Streptopelia turtur</i>			
144 a	do.	U.K.	42-51	Speedometer. Tail wind.
R.M.	do.	Palestine	38-44	Speedometer : 7 counts. Slight side wind. Migrating.
R.M.	do.	Palestine	43-45	Stop-watch : 11 counts. Migrating.
121	Palm Dove	S. Africa	42	Speedometer.
	<i>Streptopelia</i>			Normal flight.
	<i>senegalensis</i>			
79, 83	Mourning Dove	U.S.A.	26-32	Speedometer.
	<i>Zenaidura macroura</i>			Normal flight.
139	do.	U.S.A.	55	Speedometer. Chased by car.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
R.M.	Sandgrouse <i>Pterocles exustus</i>	Sudan	47-48	Stop-watch. Chased by trained tiercel. Had two outer primaries clipped.
R.M.	Sandgrouse <i>Pterocles arenaria</i>	Baluchistan	43-75	Stop-watch. Flying from water; slight head wind.
R.M.	Sandgrouse <i>Pterocles senegallus</i>	Palestine	47-5	Theodolite and range-finder. Flying to water.
R.M.	Manx Shearwater <i>Puffinus puffinus</i>	Ushant	25-34	Stop-watch : 22 counts. Birds slightly deviating from straight course.
R.M.	Fulmar <i>Fulmarus glacialis</i>	Scotland	26-39	Stop-watch : 15 counts. Birds on fairly straight course, but over short distances.
R.M.	Stone Curlew <i>Burhinus oedicephalus</i>	U.K.	30	Speedometer. Normal flight.
R.M.	Ringed Plover <i>Charadrius hiaticula</i>	Scotland	36	Stop-watch. Small flock cruising on fore-shore.
R.M.	Kentish Plover <i>Charadrius alexandrinus</i>	Palestine	34-39	Speedometer. Pressed by car.
79	Semipalmated Plover <i>Charadrius semipalmata</i>	Florida	32	Speedometer. Tail wind.
79	Killdeer Plover <i>Charadrius vociferus</i>	California	28-55	Speedometer. Several counts.
R.M.	Sand Plover <i>Charadrius geoffroyi</i>	Palestine	34-39	Speedometer. Higher speed when pressed by car.
R.M.	Caspian Plover <i>Charadrius asiaticus</i>	Kenya	47, 51	Theodolite. Migrating. Strong side wind.
R.M.	Dotterel <i>Charadrius morinellus</i>	Scotland	45-50	Stop-watch : 2 counts. Migrating.
R.M.	do.	Palestine	45, 50-5	Theodolite : 2 counts. Migrating.
1	Golden Plover <i>Charadrius apricarius</i>	U.K.	60	Airspeed indicator. Pressed by plane; migrating. Accuracy doubtful.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
79	American Golden Plover <i>Charadrius dominicus</i>	Illinois	62	Checked by pace of train.
79	Grey Plover <i>Squatarola squatarola</i>	Florida	24	Speedometer.
R.M.	Lapwing <i>Vanellus vanellus</i>	U.K.	28, 37	Cruising. Side wind. Speedometer : 2 counts. Cruising.
144 a	do.	U.K.	30-40	Speedometer : 5 counts. Easy flight.
145	do.	Germany	30	Rangefinder. Migrating; slight head wind.
R.M.	do.	Palestine	37	Theodolite. Migrating flock. head wind.
56	do.	Europe	40-45	Airspeed indicator. On migration. Of doubtful accuracy.
R.M.	Little Stint <i>Erolia minuta</i>	Tanganyika	49	Stop-watch : 1 count.
79	Sanderling <i>Crocethia alba</i>	Florida	41	Speedometer. Tail wind.
79	Western Sandpiper <i>Ereunetes maurii</i>	California	45, 52	Speedometer : 2 counts. Level flight.
R.M.	Greenshank <i>Tringa nebularia</i>	Tanganyika	46, 49	Stop-watch : 2 counts. Normal flight.
R.M.	do.	Somaliland	44	Stop-watch. Small flock moving feeding grounds.
R.M.	Marsh Sandpiper <i>Tringa stagnatilis</i>	Tanganyika	48, 51, 51.5	Stop-watch : 3 counts.
R.M.	Terek Sandpiper <i>Tringa cinerea</i>	Tanganyika	48-51	Stop-watch : 4 counts on single birds.
R.M.	do.	Somaliland	44	Stop-watch : a single bird over 430 yards.
79	Willet <i>Catophrophorus semipalmatus</i>	Florida	27	Speedometer : single count. Head wind.
79	Dowitcher <i>Limnodromus griseus</i>	California	43	Speedometer. Easy flight.
106	Snipe <i>Capella gallinago</i>	U.K.	25	Instrument. Normal flight previous to "drumming".
106	do.	U.K.	25-50	Instrument. Increase to act of "drumming".

TABLE A.—Continued.

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
R.M.	Snipe <i>Capella gallinago</i>	U.K.	34.7	Stop-watch. Flight for 320 yards when flushed with much deviation during first 80 yards.
R.M.	Pin-tailed Snipe <i>Capella stenura</i>	Bengal	26-31	Stop-watch : 3 counts. From flushing to settling over 340 yards.
R.M.	Woodcock <i>Scolopax rusticola</i>	Scotland	44.6	Stop-watch. Flushed on hillside; open country.
R.M. 83, 102	do. American Woodcock <i>Scolopax minor</i>	Cumberland U.S.A.	27.2 13, 35	Stop-watch. "Roding." Speedometer. Normal flight and when chased by car.
R.M.	Oystercatcher <i>Haematopus ostralegus</i>	Tanganyika	45-49	Stop-watch : 7 counts. Birds moving feeding grounds.
62, 66	do.	U.K.	32, 35	Speedometer : 2 counts. Normal cruising.
66	Curlew <i>Numenius arquatus</i>	U.K.	20	Speedometer. Normal slow flight.
142	do.	Ireland	60	Airspeed indicator. When pressed by plane. Of doubtful accuracy.
R.M.	do.	Tanganyika	42-48.25	Stop-watch : 17 counts. Normal flight.
R.M.	Whimbrel <i>Numenius phaeopus</i>	Ireland	40-45	Stop-watch : several counts. Migrating. 15 m.p.h. head wind.
R.M.	do.	Tanganyika	43-52	Stop-watch : 9 counts. Normal flight.
79	Long-billed Curlew <i>Numenius americanus</i>	U.S.A.	35	Speedometer. Head wind.
79	Hudsonian Curlew <i>Numenius hudsonicus</i>	Florida	34	Speedometer. Side wind.
66, R.M., 108	Herring Gull <i>Larus argentatus</i>	U.K.	18, 20, 21-36	Speedometer : 7 counts. Flapping flight.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
144 a	do.	U.K.	17-20	Speedometer : 3 counts. Easy flight, flapping.
50	Lesser Black-backed Gull	Germany	31	Instrument. Migrating. Flapping.
R.M.	<i>Larus fuscus</i> "Gulls"	Suez Canal	31-34	Stop-watch. Migrating. Flapping.
144 a	<i>L. argentatus</i> & <i>fuscus</i> Common Gull	U.K.	23	Speedometer. Leisurely flight against slight breeze; flapping.
66	<i>Larus camus</i> Black-headed Gull	U.K.	21-30	Speedometer. Cruising by flapping flight.
144 a	do.	U.K.	20, 21.5	Speedometer. Leisurely flight going to roost.
66, 79, 83	Common Tern	U.K.	13, 15-29	Speedometer. Cruising.
144 a	<i>Sterna hirundo</i> do.	U.K.	25, 27	Speedometer. Easy flight.
79	Black Skimmer	Florida	18	Speedometer : 2 birds cruising; head wind.
R.M.	<i>Rhynchops niger</i> Razorbill	Ushant	49-54	Stop-watch : 8 counts. Migrating.
60	<i>Alca torda</i> Guillemot	Atlantic	50-55	Estimated from speed of ship.
R.M.	<i>Uria aalge</i> Puffin	Shetland	25, 28-29	Stop-watch : 5 counts. Normal flight when disturbed.
R.M.	<i>Fratercula arctica</i> do.	Cornwall	48-51	Stop-watch : 7 counts of birds bringing food to young.
R.M.	Houbara Bustard	Baluchistan	42.25	Stop-watch : single count. Normal flight.
145	<i>Chlamydotis undulata</i> Crane	Germany	22-36	Rangefinder : 9 counts. Migrating. Slight head wind.
145	<i>Grus grus</i> do.	Germany	36	Rangefinder. Migrating; 4 m.p.h. tail wind.
145	do.	Germany	30	Rangefinder. Migrating; 14 m.p.h. head wind.

TABLE A.—Continued.

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
R.M.	Demoiselle Crane <i>Anthropoides virgo</i>	Iraq	37–41, 47	Airspeed indicator. Last figure when pressed by plane; doubtful accuracy.
72	Red Grouse <i>Lagopus scoticus</i>	Scotland	56–58	Airspeed indicator. Chased by plane; doubtful accuracy.
66	do.	Scotland	47	Speedometer. Normal flight.
79	Ruffed Grouse <i>Bonasa umbellus</i>	New Hampshire	22	Speedometer.
92	Capercaillie <i>Tetrao urogallus</i>	Scotland	51–52	Speedometer. Timed over 600 yards.
79	Bobwhite <i>Colinus virginianus</i>	Carolina	48	Stop-watch. Maximum speed.
66, 98, 118	Partridge <i>Perdix perdix</i>	U.K.	25–35, 39, 40, 53	Speedometer. Three highest speeds when pressed.
98	do.	U.K.	30	Instrument. Immediately after rising.
56	do.	U.K.	40	Airspeed indicator. Going all out; of doubtful accuracy.
144 a	do.	U.K.	41	Speedometer. Pressed.
18	do.	U.K.	32	Instrument. Normal flight.
151	do.	U.K.	45	Checked by train speed.
151	do.	U.K.	28, 32	Stop-watch. In covered gallery and in open.
137	do.	U.K.	42	Speedometer. Pressed over 150 yards distance.
195	do.	U.K.	56	Speedometer. Tail wind of about 12 m.p.h.
19	Quail <i>Coturnix coturnix</i>	Mediterranean	57	Stop-watch. Migrating.
72	do.	Mediterranean	30–35	Airspeed indicator. Migrating; of doubtful accuracy.
151	Pheasant <i>Phasianus colchicus</i>	U.K.	33, 38	Stop-watch. In covered gallery and in the open.

TABLE A.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Method of measurement and remarks
128, 129, 130	do.	U.K.	35-40	Speedometer. Pressed by car.
18, 98	do.	U.K.	30-38, 60	Instrument. Highest speed with tail wind.
117	Wild Turkey <i>Meleagris gallopavo</i>	Virginia	29-42	Speedometer. In full flight.
R.M.	Wild Ostrich <i>Struthio camelus</i>	Kenya	36, 37	Speedometer. Female and male going full out in front of car.
R.M.	Adélie Penguin <i>Pygoscelis adeliae</i>	London Zoo	8.1-8.5	68 feet under water after food. Stop-watch.
R.M.	King Penguin <i>Aptenodytes patagonica</i>	London Zoo	6.9-7.8	Leisurely cruise under water for 50 feet. Stop-watch.

TABLE B. *Altitude of bird flight.*

Note.—The significant feature of altitude of flight is height above ground level. In most of the following cases the altitude shown is either specifically above ground level or can be deduced (from a knowledge of the local topography) to be approximately above ground level. In all cases in which this does *not* apply the altitude is bracketed.

Ref.	Species	Place	Altitude	Remarks
R.M.	Rooks <i>Corvus frugilegus</i>	France	1740, 2008, 2120	Theodolite; autumn; by day.
A. 32	do.	Salisbury	11,000	Flying S.E. in May.
A. 35	do.	Germany	2400-7500	Theodolite; in spring. 10 observations.
A. 23	do.	France	(3000), (6000)	Airman : July and March.
R.M.	Rooks and Jackdaws <i>C. frugilegus</i> and <i>C. monedula</i>	France	690	Theodolite. By day.
R.M.	do.	Iraq	800	Theodolite; autumn; by day.
R.M.	Choughs <i>Pyrrhocorax graculus</i> and <i>P. pyrrhocorax</i>	Karakoram	(19,000) (21,000)	Aneroid. Summer. Taken from 19,000.
A. 23	Starling <i>Sturnus vulgaris</i>	France	(3500)	Airman.

TABLE B.—Continued.

Ref.	Species	Place	Altitude	Remarks
A. 54	Starling <i>Sturnus vulgaris</i>	France	3500	Theodolite; autumn; average of several observations.
A. 23	Linnetts ? <i>Carduelis cannabina</i>	France	(10,000)	A flock in August. Airman.
A. 54	Meadow Pipit <i>Anthus pratensis</i>	Tuskar Rk.	70	Average height.
R.M.	Red-throated Pipit <i>Anthus cervinus</i>	Kenya	210	Theodolite; by day; autumn.
R.M.	Yellow Wagtail <i>Motacilla flava</i>	Kenya	160–240	Theodolite; by day; autumn.
A. 54	Wagtails <i>Motacilla</i> sp.	Tuskar Rk.	120	Average height.
R.M.	Wall Creeper <i>Tichodroma muraria</i>	Karakoram	(19,000)– (21,000)	Aneroid. Taken from same levels.
R.M.	Thrushes ? <i>Turdus</i> sp.	Syria	c. 500	Migrating over desert in autumn. Height estimated.
A. 23	Fieldfares ? <i>Turdus pilaris</i>	France	(3500)	Airman. March. Flock.
R.M.	Swallows <i>Hirundo rustica</i>	Kenya	235	Theodolite. By day. Spring.
A. 54	do.	Tuskar Rk.	40	Average height.
A. 48 a	Swifts ? <i>Apus apus</i>	Scotland	(5000)	Airman. In March. Birds in flock, per- haps Swallows. Above cloud ceiling.
191 c	Swift <i>Apus apus</i>	Switzerland	4100–6000	Aircraft : dusk and dawn.
191 e	do.	Germany	2200	Balloon. In June.
193	do.	Holland	6700	Aircraft. Early August, above cloud ceiling.
194	do.	Westmor- land	2800–3400	Aircraft. Feeding in July.
A. 34	do.	Iraq	6000	Airman. July.
A. 30	do.	France	(9500)	Airman. August.
R.M.	Roller <i>Coracias garrulus</i>	Kenya	720	Theodolite; autumn passage.
R.M.	Bee-eater <i>Merops apiaster</i>	Kenya	4800	Airman. Flock on spring passage.
R.M.	Kestrel <i>Falco tinnunculus</i>	Kenya	150–310	Theodolite; by day; autumn.
A. 32	do.	Birmingham	7000	Airman. Single bird; January.
A. 40	Sparrowhawk <i>Accipiter</i> sp.	Jerusalem	3000	Estimated only; spring passage.

TABLE B.—Continued.

Ref.	Species	Place	Altitude	Remarks
A. 32	Lammergeier	Italy	(11,000)	Airman; single bird;
A. 52	<i>Gypaetus barbatus</i>			January.
	do.	Everest	(24–25,000)	Estimate only; single bird.
A. 20	Condor	Andes	(19,800)	Aneroid.
	<i>Vultur gryphus</i>			
A. 4	White Stork	Himalayas	(14,000)	In May, flying N.E.
	<i>Ciconia ciconia</i>			
R.M.	do.	Jordan Valley	400–2000	Theodolite; migrating in March.
A. 34	do.	Iraq	4200	Airman. April.
A. 23	Heron	France	(3000)	Airman.
	<i>Ardea cinerea</i>			
A. 54	do.	Essex	2500–3000	Airman. September.
A. 26,	“ Egrets ”	S. Africa	(c. 5200)	Telescope at night,
A. 37				crossing moon.
A. 20	Pink-footed Geese	Carlisle	7000	Airman. October.
	<i>Anser brachyrhynchus</i>			
R.M.	Barnacle Geese	South Uist	2800	Estimate from surrounding hills; migrating; November.
	<i>Branta leucopsis</i>			
A. 54	“ Geese ”	Flanders	8000–9000	Airman.
A. 1	do.	France	(6000)	Airman. 2 observations.
A. 45	do.	?	(905)	Airman.
A. 23	do.	France	(3000–9000)	Airman; 4 observations.
A. 32	do.	Scotland	(700)	February.
A. 34	Geese and duck	Iraq	2000–3000	Airman. Spring migration.
A. 45	Duck	?	958	Airman.
A. 32	do.	France	(7500)	Airman. Birds flying south in snowstorm. November.
R.M.	do.	Finland	3000+	Instruments. Autumn.
R.M.	Pelican	Palestine	1240	Theodolite. May. Flying north. Ground about +600 feet a.s.l.
90	Cormorant	Leicester	2500	Airman. Migrating flock.
R.M.	do.	Karachi	2000	Height estimated. Daily movement to roost. Many thousands of birds.

TABLE B.—*Continued.*

Ref.	Species	Place	Altitude	Remarks
A. 35	Woodpigeon <i>Columba palumbus</i>	Germany	(2400–5100)	Instruments; spring passage travelling northeast. 8 observations.
R.M.	do.	North Sea	500	Theodolite; autumn passage; a single flock. Daylight.
R.M.	do.	S. Greece	(12,000)	Aircraft; above cloud level; a large flock flying north.
A. 40	Stockdove <i>Columba oenas</i>	Orenberg	400	Autumn passage.
A. 32	" Pigeon "	France	(8000)	Flock of 20 in March. Airman.
35	Homing Pigeon	France	(2800)	Airman. A single bird.
R.M.	Caspian Plover <i>Charadrius asiaticus</i>	Kenya	(480)	Theodolite. Autumn passage by day.
A. 32	Golden Plover <i>Charadrius apricarius</i>	Gallipoli	6600	Airman. December.
R.M.	Green Plover <i>Vanellus vanellus</i>	France	(1410)	Theodolite. Autumn.
A. 23	do.	France	(2000–8500)	Airman. 14 observations. Autumn migration.
A. 26 b	do.	Glos.	(4600)	Flock in January. Above cloud level. Airman.
A. 24	do.	France	(6000)	Airman. September; flying north.
A. 25	do.	France	(5000)	Airman. Flying north.
A. 32	do.	France	(6500)	Airman. March.
A. 32	do.	Eastbourne	8000	Airman. October.
A. 32	do.	France	(1400)	Airman. Above cloud level in December.
A. 35	do.	Germany	(1300–1800)	Theodolite; spring; 2 observations.
R.M.	do.	Egypt	8400	Airman; spring passage.
A. 50	do.	France	(5500)	Airman; spring passage.
R.M.	do.	Irish Channel	8400	Airman; above cloud level in March.
A. 54	do.	Europe	(2000–8500)	Airman; 14 observations.

TABLE B.—Continued.

Ref.	Species	Place	Altitude	Remarks
A. 54	Whimbrel <i>Numenius phaeopus</i>	France	(4000)	Airman. March, flying northeast.
A. 54	do.	France	(4000)	Airman; migrating. March.
A. 52	" Godwit and Curlew "	Mt. Everest	(20,000)	Migrating south. Elevation known from observation point.
R.M.	Woodcock	Ireland	(3000)	A single bird colliding with aircraft in August.
A. 23	" Sandpipers "	France	(12,000)	Airman; flying east in March.
A. 23	" Waders "	France	(9500–10,000)	Airman. 2 observations in December.
103	" Small waders "	California	(1500)	Migrating at dusk in April.
A. 31	" Gulls "	North England	3000	By day. Migrating over land.
A. 6	Crane <i>Grus grus</i>	Himalayas	20,000	Observed from 14,000 feet; by day.
R.M.	do.	Iraq	4000	Moving southwest by day.
A. 23	do.	France	(8000, 15,000)	Airmen. April and August.
A. 35	do.	Germany	(2,000, 6300)	Range-finder. Spring, travelling northeast.
R.M.	do.	Finland	9000	Instruments. Autumn.
R.M.	do.	Pyrenees	1500–1800	Estimate only.
R.M.	do.	Damascus	4000	October. Range-finder.
A. 54	do.	France	(15,000)	August; migrating; airman.
R.M.	Demoiselle Crane <i>Anthropoides virgo</i>	Iraq	4300–4400	November, by day. Airman; several observations.
R.M.	do.	Iraq	1100–4400	Autumn, travelling southwest. Airman.
A. 10	" Birds "	New Jersey	5000–10,000	October. Crossing the moon by night. Unreliable.
A. 10	do.	New Jersey	1500–15,000	September. Crossing the moon by night. Unreliable.

TABLE C. *Wing beats.*

In the Table below, all figures are beats per minute, taken by stop-watch by me personally. Blake (Auk 1947 : 619) records wing beats which I find, when capable of comparison with my figures, are considerably less. I am unable to account for this discrepancy.

Species	Place	Beats per minute	Remarks
Raven	U.K.	216	Flying to roost at 33 m.p.h.
do.	U.K.	210	Beating up-wind.
do.	U.K.	174-216	Leisurely to hurried.
Carrion Crow	U.K.	252	Rising from ground.
do.	U.K.	210-222	Leisurely to hurried.
Raven	Palestine	156	Leisurely at 22 m.p.h.
do.	Palestine	204	Flying to roost at 37 m.p.h.
Fan-tailed Raven	Arabia	198-216	Cruising.
do.	Arabia	264-270	Rising from ground.
Rook	U.K.	132-150	Leisurely at 24 m.p.h.
do.	U.K.	183	Hurried. At 35 m.p.h.
do.	U.K.	184	Rising when frightened.
Jackdaw	U.K.	254	Hurried off nest.
do.	U.K.	222-240	Cruising between 30-36 m.p.h.
Jungle Crow	India	196-203	Cruising.
Magpie	Ireland	180	Tree to tree.
Starling	U.K.	348	Rising from ground.
do.	U.K.	450	Hurried; to roost at 47 m.p.h.
do.	U.K.	300-312	Normal cruising; 27-29 m.p.h.
Blackbird	U.K.	336	Hurried. 30 m.p.h.
Pied Kingfisher	Egypt	294	Cruising.
do.	Egypt	326	Hovering.
Cuckoo	U.K.	288	Cruising. 24 m.p.h.
Short-eared Owl	Scotland	144-168	Cruising to hunting.
Peregrine Falcon	U.K.	258-264	Hunting.
Barbary Falcon	Sudan	294-296	In level chase after sand-grouse.
Saker Falcon	India	252	Unhurried flight.
Merlin	U.K.	294	Fast cruising; 36 m.p.h.
Kestrel	U.K.	208	Cruising.
do.	Ireland	216	Cruising.
Hen Harrier	Scotland	181-204	Cruising and hunting.
Montagu's Harrier	Palestine	186	Hunting.
Pallid Harrier	Arabia	164	Beating up-wind.
Black Kite	Iraq	165-180	Normal flight.
do.	Sudan	162-174	Normal flight.
do.	Sudan	198	Hurrying to food.

TABLE C.—*Continued.*

Species	Place	Beats per minute	Remarks
Osprey	Sudan	306	Rising from water.
do.	Iraq	204–210	Normal cruising.
do.	Aden	240–246	Hunting over the sea.
African Sea Eagle	Uganda	168	Rising from water.
<i>Haliaeetus vocifer</i>			
Egyptian Vulture	Egypt	144–180	Cruising to hurried.
Marabou Stork	Sudan	150	Rising.
<i>Leptoptilos</i>			
Heron	U.K.	108	Flying lazily, 25 m.p.h.
do.	U.K.	150–176	Cruising at 28 m.p.h.
Great White Egret	Kenya	126	Cruising.
<i>Ardea alba</i>			
Flamingo	Red Sea	204	Cruising.
<i>Phoenicopterus ruber</i>			
Mute Swan	U.K.	160	Flying down-wind.
do.	U.K.	191–200	Cruising in rough weather.
do.	Ireland	192	Leisurely cruising.
Shelduck	U.K.	180	Flying down-wind.
do.	U.K.	230	Flying into wind.
Egyptian Goose	Sudan	271	Rising.
<i>Alopochen</i>			
do.	Sudan	216–258	Cruising.
Mallard	U.K.	301–306	Cruising.
Gadwall	India	300	Cruising.
Wigeon	Ireland	306	Rising from water.
Shoveler	U.K.	302	Cruising.
do.	U.K.	351	Rising.
Common Scoter	U.K.	288, 300	Cruising.
Velvet Scoter	U.K.	257	Cruising.
Eider Duck	U.K.	276, 294	Cruising.
Merganser	Ireland	276	Cruising.
Pelican	Sudan	168–180	Cruising.
<i>P. onochrotalus</i>			
Gannet	U.K.	216, 228, 259	Rising from water.
do.	U.K.	164–210	Cruising.
Cormorant	U.K.	200–264	Cruising.
<i>P. carbo</i>			
Shag	U.K.	240–330	Cruising.
<i>P. aristotelis</i>			
Great Crested Grebe	U.K.	360–400	Cruising.
Great Northern Diver	U.K.	256–262	Cruising.
Fulmar	U.K.	177–258	Cruising.
Manx Shearwater	U.K.	240	Cruising with much gliding.
do.	U.K.	286, 326	Cruising without gliding.

TABLE C.—*Continued.*

Species	Place	Beats per minute	Remarks
Woodpigeon	U.K.	180	Slow flying, 41 m.p.h.
do.	U.K.	302	Fast flying, 49 m.p.h.
do.	U.K.	312	Rising.
Rock Pigeon	Scotland	242–307	Cruising.
do.	Iraq	228–252	Cruising.
do.	Iraq	282	Frightened.
Dove	Kenya	230	Slow cruising.
<i>Streptopelia decipiens</i>			
Dove	Kenya	360	Hurried flight.
<i>Streptopelia senegalensis</i>			
Sandgrouse	Sinai	306	Flying to water.
<i>Pterocles senegallus</i>			
Sandgrouse	Sudan	362	Chased by falcon.
<i>Pterocles exustus</i>			
Egyptian Plover	Sudan	270	Rising.
<i>Pluvianus</i>			
do.	Sudan	228, 246, 264	From leisurely to hurried.
Ringed Plover	U.K.	318	Cruising.
Golden Plover	U.K.	242	Cruising.
Spur-winged Plover	Egypt	144, 174	Leisurely to hurried.
<i>Hoplopterus</i>			
Lapwing	U.K.	150, 168	Slow flying, 29 m.p.h.
do.	U.K.	187, 212	Normal cruising, 34 m.p.h.
do.	U.K.	282, 286	Courtship flight.
do.	Ireland	246	Rising.
Turnstone	U.K.	240	Cruising.
Redshank	U.K.	242	Rising from ground in spring.
do.	U.K.	252	Rapid flight in rough weather.
do.	U.K.	336	Frightened.
Ruff	Sudan	210–282	Slow flying to hurried.
Oystercatcher	U.K.	240–258	Cruising.
Curlew	U.K.	198, 225	Slow flying.
do.	U.K.	246, 252	Rapid flying.
do.	Ireland	210, 258	Rising leisurely and scared.
Snipe	Ireland	348	Against a strong wind.
Greater Black-backed Gull	U.K.	210	Chasing another gull.
do.	U.K.	141–186	Slow to rapid cruising.
Lesser Black-backed Gull	U.K.	170–173	Doing 12½ m.p.h. against wind when following ship.
Herring Gull	U.K.	156–183	Slow to rapid cruising.

TABLE C.—*Continued.*

Species	Place	Beats per minute	Remarks
Common Gull	U.K.	252	Rising from ground.
do.	U.K.	168–192	Slow to rapid cruising.
Black-headed Gull	U.K.	156–186	Normal cruising.
Hemprich's Gull	Red Sea	162–192	Slow to rapid cruising.
Kittiwake	U.K.	192, 210	Higher figure at 15 m.p.h.
<i>Rissa</i>			
Sandwich Tern	U.K.	134, 150	Cruising.
Tern	India	134–150	Cruising.
<i>Sterna melanogaster</i>			
Puffin	U.K.	388, 400	Rising from water.
do.	U.K.	371	Hurrying across bows of ship.
do.	U.K.	320–360	Cruising.
Guillemot	U.K.	348	Rising from water.
do.	U.K.	270	Cruising.
Black Guillemot	U.K.	482	Cruising.
do.	Ireland	324	Cruising.
Coot	Ireland	350	Cruising.
Pheasant	Ireland	540	Rising.
Capercaillie	Scotland	270, 276	Males taking off from trees.
<i>Tetrao urogallus</i>			
do.	Scotland	258–272	Level flight during "shoot".

APPENDIX.

Velocity of mammal movement.

Ref.	Species	Place	Ground speed m.p.h.	Remarks
98	African Elephant	Africa	24	Stop-watch; animal scared over distance of 120 yards.
98	African Rhinoceros	Africa	28, 35	Speedometer : 2 counts.
R.M.	do.	Africa	32–35	Speedometer; galloping.
				Charging a motor car.
R.M.	do.	Africa	27.2	Stop-watch. Trotting.
				(Chasing a Masai.)

APPENDIX.—*Continued.*

Ref.	Species	Place	Ground speed m.p.h.	Remarks
R.M.	Cheetah <i>Acinonyx jubatus</i>	London	44	Stop-watch : 3 counts. Chasing electric hare on dog race-track.
190	Fox	Ireland	25-28	Speedometer: maximum.
157	Mongolian Wolf <i>Canis lupus</i>	Mongolia	36	Speedometer. Chased by motor car.
152	Greyhound	U.K.	40	Stop-watch on race track. Maximum speed.
R.M.	African Wild Dog <i>Lycaon pictus</i>	Uganda	38	Speedometer. Chased by car on road.
R.M.	Atlantic Seal <i>Halichoerus grypus</i>	London Zoo	4.3-4.9	Stop-watch. Under-water movement over 26 feet after food; an immature beast.
R.M.	Californian Sea Lion <i>Zalophus californianus</i>	London Zoo	10.2-10.6	Stop-watch. Under-water movement over 75 feet after food.
155	Dolphin <i>Delphinus</i> sp.	—	20-25	Checked by ship's speed.
R.M.,	English Hare <i>Lepus timidus</i>	U.K.	34-38, 45	Speedometer. Pressed by motor car.
133				
152	Race Horse	U.K.	40-41	Stop-watch. Flat race, carrying 7-8 stone.
152	do.	Grand National	28-82	Stop-watch. Carrying 12 stone.
152	do.	Derby Stakes	36	The Derby winner in 1936.
157	Wild Ass <i>Equus hemionus</i>	Mongolia	36-40	Speedometer. Maximum speed when pressed.
98	Antelope sp.	Gobi Desert	60	Speedometer. Going full out over short distance.
R.M.	Coke's Haartebeeste <i>Alcelaphus buselaphus</i>	Kenya	37-38	Speedometer : 2 counts. Going full out in front of car over a mile.
R.M.	Blue Wildebeeste <i>Connochaetes taurinus</i>	Kenya	34	do. : 1 count.
154	Bat sp.	U.S.A.	10	Instruments. Flying.
R.M.	Man	Kenya	18.4	Stop-watch. A Masai warrior with spear and shield chased by a rhinoceros.
187	do.	U.S.A.	21.9	World's record by Patton for 100 yards in 1948.
187	do.	Sweden	14.9	World's record by Haegg for one mile in 1945.

Velocity of reptile movement.

A Black Mamba *Dendroaspis polylepis* when pressed in Kenya over short grass could not exceed 7 m.p.h. (R.M.), and a Grass Snake *Natrix natrix* could not exceed 4.2 m.p.h. (155, R.M.).

Mosauer (Copeia 1935 : 6-8) gives the following velocity of snakes taken under natural conditions.

Species	Speed : m.p.h.		No. of trials
	prowling	maximum	
California Boa <i>Lichanura roseofusca</i>	0.09	0.224	7
Coral King Snake <i>Lampropeltis multicincta</i>	0.173	0.720	12
Gopher Snake <i>Pituophis catenifer</i>	0.134	1.18	36
Patchnosed Snake <i>Salvadora hexalepis</i>	0.224	1.43	12
Sidewinder Snake <i>Crotalus cerastes</i>	0.313	2.04	41
Red Racer Snake <i>Coluber flagellum</i>	0.286	3.6	39

A Varanus Lizard *Varanus griseus* between Cairo and Suez when racing for its hole could just do 14 m.p.h., and an ancient Giant Tortoise in Mauritius when hungry and enticed by a cabbage could not exceed 5 yards in a minute. (Both records R.M.)

Velocity of fish movement.

Salmon *Salmo salar* are credited with 23 m.p.h. over short distances and with 14-17 m.p.h. when ascending waterfalls. A hooked 20 lb. fish ran out line at the rate of 10 m.p.h. (134).

A nine-inch trout *Salmo trutta* when hooked ran out line at the rate of 5 m.p.h. in its first rush (R.M.).

Flying fish *Cypsilurus cyanopterus* when air-borne are credited with 30-35 m.p.h. (R.M.).

Velocity of insect movement.

Ref.	Species	Place	Ground speed m.p.h.	Remarks
R.M.	Peacock Butterfly	Hampshire	5.7-5.81	Stop-watch over 42 yards. Flight slightly zig-zag.
99	Wasp	—	12	Instruments. Going all out.
99	Hornet	—	13.3	do. do.
99	Bumble Bee	—	11	do.
99	Honey Bee	—	5.25	Laden with honey.
159	do. (workers)	—	8.4-13.77	Stop-watch; photoelectric method.
159	do. (drones)	—	3.8	do.
99	American Bot-fly	—	25	Instruments.
	<i>Tabanid</i>			
159	Horse Fly	—	31.5	Stop-watch.
	<i>Tabanus bovinus</i>			
159	do.	—	9	Stop-watch; attached to thread.
159	Horse Fly	—	28.1	Checked by speed of train.
	<i>Tabanus affinis</i>			
134	do.	—	8.8	Instrument.
159	Unspecified Tabanids		40.5	Speedometer.
R.M.	Bluebottle Fly	London	8.7	Stop-watch. A frightened insect over 17 yards in a room.
	<i>Calliphora</i> sp.			
99	House Fly	—	5	Instruments.
159	<i>Drosophila</i> sp.	—	9.45	?
99	Hawk Moth		33+	Instruments.
	<i>Sphingidae</i>			
99	Dragonfly	Australia	55-60	Instruments.
	<i>Austrophlebia</i>			
134	Dragonfly	—	15.6	Instruments.
	<i>Aeshna</i>			
99	Mayfly	—	1.1	?
159	Mosquito	—	0.7-0.9	Instruments.
	<i>Aedes aegypti</i>			
159	Mosquito	—	0.18-0.74	Instrument; in 25-foot tunnel.
	<i>Anopheles fuliginosus</i>			
159	Mosquito	—	0.18-0.74	do. do.
	<i>Mansonia uniformis</i>			
155	Flea	—	4.5	Laboratory experiment. Jumping 8 inches horizontally.