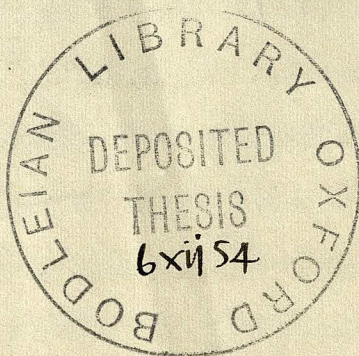


THE TAXONOMY AND ECOLOGY OF THE
BRITISH SPECIES OF DROSOPHILA

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Abstract of Thesis for the Degree of Doctor
of Philosophy



ABSTRACT

Various species of Drosophila, because of their short generation time and large salivary gland chromosomes, have proved to be admirably suited for genetics research. In recent years, the great steps taken in studies of population genetics and evolutionary investigations have made it increasingly important that the taxonomy, distribution, and ecology of the various species should be studied.

In Great Britain, there are twentyeight species on the check list. Twenty-one of them have been classified into four of the five subgenera set out by Starck; seven of them are as yet unclassified. A key is given for the British species of Drosophila, with references to full descriptions of the various species by other authors.

Where the nomenclature of a particular species is confused, it is discussed.

Collections were made in 28 woodland localities in Southern England. Over 30,000 specimens of Drosophila were caught and identified. The collecting technique, using a glass funnel, and cups with mashed fruit bait, was chosen to make results comparable with those of recent Drosophila workers. Of the twenty-two species which were caught, eleven appear to be general in their distribution. D. helvetica is apparently limited by low winter temperatures, and is confined to Southern and Western England; D. busckii was caught in

large numbers only in Norfolk; and the remaining nine species were not caught in sufficient numbers to analyze their geographical distribution.

The species frequencies are found to vary greatly between types of habitats (scrub, woodland and wood margin; sites on farms and around houses; and open meadows). D. subobscura is usually the most abundant species in all three classes of habitats, and is almost the only species caught in the open meadow. The frequencies of the different species is also quite different between adjacent (but unlike) woodlands. It was not possible to associate the abundance of a particular species with a particular kind of plant. The species frequencies during the summer months were studied by making monthly collections (May to September). There is a seasonal change in the relative abundance of the different species.

The diurnal periodicity of the British Species was analysed. The activity of D. subobscura and D. obscura was studied in the greatest detail, since these species were caught in the largest numbers, D. subobscura usually shows a morning and evening peak of and a mid-day decrease in activity, whereas D. obscura shows a morning beginning of activity and an evening cessation, but no regular peaks during the day. It is shown that D. subobscura (the species which inhabits both meadows and woodlands) ceases flying with high and low light, and has a narrow range of optimum light; whereas D. obscura (the woodland species) ceases flying with low light, but has

a much wider light tolerance, which is not often exceeded in the woodland shade. Other species were caught in numbers too small to permit analysis of the causes of their activity.

The responses of D. subobscura and D. obscura to experimental temperature and humidity gradients were tested. Both species respond to these factors, but respond more strongly to small differences in light than to great differences in humidity. Although there is some difference in the orientation of these two species with respect to these factors (D. obscura preferring a slightly lower temperature), it is insufficient to explain why D. subobscura has been able to colonize the open meadow and D. obscura has not.

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CHAPTER I
INTRODUCTION

INTRODUCTION

In the last fifty years, the genus Drosophila has become one of the most important tools for research in genetics, and evolutionary studies. In 1901, a student of the American geneticist, Morgan, began experiments with the small 'fruit fly', D.melanogaster, and found that it possessed the advantages for laboratory work of being easy to culture, and having an exceedingly rapid rate of reproduction (15 days at 20°C). The speed with which the basic concepts of the science of genetics have been developed since the rediscovery of Mendel's laws in 1900 is due, at least in part, to the rapid breeding of this small fly.

About twenty years ago, Painter and others discovered that Drosophila also possess giant chromosomes (first noted in 1881 by Balbiani, in the salivary glands of the larvae of Chironomus). This made the genus Drosophila, and in particular the rapid-breeding D.melanogaster, an obvious choice for the study of chromosomal inversions, translocations, deletions and reduplications. Once again, the suitability of the material speeded the appreciation of phenomena important for the understanding of heredity and evolution.

Only within the last fifteen years, however, have scientists really become interested in Drosophila as an animal rather than as merely a genetic tool. Sturtevant's

work on "the North American Species of the Drosophila" was a prologue to a series of taxonomic studies, but the whole tone of the work is that of Museum taxonomy. The real beginning of the "new systematics" of the genus Drosophila was marked by Sturtevant's revision of the subgenera of the genus and his attempt to determine the relationship between the various groups. This was followed by many excellent studies of the taxonomy and distribution of Drosophila.

A series of publications by Patterson and his co-workers on the Drosophila of various regions of the United States and Mexico followed Sturtevant's revision of the genus, while Dobzhensky and others initiated extensive studies of the Drosophila fauna of Brazil. An excellent survey of the Swiss Drosophila has been accomplished by Burla; and Hadorn and his co-workers have collected in France, Spain and Portugal. More recently, Basden has started to publish the results of collections made principally in Scotland; Burla has just completed a survey of the Drosophilidae of French West Africa; and Lever and Sobels are at present studying the Dutch Drosophila. Information about the geographical distribution of the genus is gradually accumulating, yet large gaps in our knowledge remain.

In addition to studying the taxonomy and distribution, geneticists are beginning to concern themselves with the ecology and population structure of Drosophila species. At first, these studies (by Dubinin, and Timofeef-Ressovsky, among others) were

primarily concerned with D. melanogaster and D. funebris (another cosmopolitan species which has been used for genetics research). D. melanogaster is probably originally a tropical species which has, however, become adapted to living in and near human habitation, and shows what is probably an atypical life-cycle.¹

For this reason, Dobzhansky, Spencer and other workers extended their interest to other species of Drosophila. Dobzhansky chose to work on the ecology and population genetics of the obscura group (since it is composed of species which avoid the habitation of man, and have a life-cycle which he considers to be more interesting for evolutionary studies) and his investigations revealed, among other things, two exceedingly interesting phenomena. Firstly, two of the species which Dobzhansky studied (D. pseudoobscura and D. persimilis) are almost identical morphologically, yet chromosomal analysis and study of wild populations show them to be true, non-interbreeding species. Thus they provide one of the most extreme examples of 'sibling species'. Secondly, investigations of chromosomal polymorphism in D. pseudoobscura and D. persimilis showed regular, cyclical changes during the year in the frequency of different chromosomal inversions. This demonstrated convincingly that natural selection acts not only on visible morphological characteristics:

1. A wild population of D. melanogaster apparently originates from a few individuals which manage to survive the winter, and the offspring build up large local populations during the summer. These populations are unusual in that they originate from only a few individuals, and probably have less genetic variability than would be found in a more stable population.

but also on physiological traits.

Further work on chromosomal polymorphism of a Brazilian Drosophila, D. willistonii, revealed that this species has a large number of different chromosomal inversions. Since this is a tropical species, and tropical rain forests provide a very lush habitat, Da Cunha, Burla and Dobzhansky (1950) have postulated that chromosomal polymorphism enables a species to occupy a variety of ecological niches.

Investigations of Drosophila, which began because of the convenience of certain species as a genetic tool, have now turned to topics of significance to evolution and ecology. Information about the genus is rapidly accumulating, but much remains to be learned. Although the genetics of certain species is known fairly well, less is known about the distribution, exceedingly little is known about the food habits and breeding sites, and the larvae of most species have not been found. Workers in the United States have found the larvae of D. americana in cracks in the bark of willows; while D. mulleri and D. aldrichi apparently breed in the fruit of the desert cactus, Opuntia. In Europe, numerous species have been bred from fungi; H. obscura has been found very occasionally on slime fluxes; while D. subobscura has been bred from rotting iris roots, and blackberries. If we accept Elton's definition of ecological niche as "the place (of the animal) in the biotic environment, its relations to food and enemies"

(Elton 1947: 64), it is clearly difficult to discuss adequately the ecology of a particular species when so little is known about either the enemies or the food. Since they are characterized by small sized larvae which are difficult to find, Drosophila species are not as well suited to ecological investigations as they are to genetics research.

The extensive, but in places patchy, knowledge of the genus Drosophila determined the starting point and scope of the work presented here. Before a study of the complex and important factors of Drosophila ecology is possible, a great deal of preparatory work on taxonomy and distribution was obviously necessary. Since my area of investigation was England, there were two primary lines of enquiry; firstly, what are the British species of Drosophila? and secondly, what is their distribution? Out of this, the supplementary problems (the reasons for their general distribution patterns; and the reactions of adults to local environment) arose. It was desirable that these field observations should be supplemented by experimental work.

Knowledge of the British species of Drosophila is meager and often confused. This work begins, of necessity, with a study of the taxonomy of the British species, followed by details of the distribution of the various species in Southern England. Approximately 30,000 specimens of the genus were collected and identified by me for this study. In connection with geographical distribution, the variations in species frequencies

with habitat and time of year were investigated, and the reactions of the adults to local environment (temperature, humidity and light) were analysed in detail. Furthermore, to supplement the often difficult analysis of purely observational data, detailed comparisons were made of the response, under experimental conditions, of two species to temperature and humidity gradients. The species used were D. obscura and D. subobscura, since more field data was available for them than for other species.

In conclusion, the literature on Drosophila must be mentioned. At least 500 articles relating to Drosophila have been published within the last three years. A comprehensive review of the literature on all aspects of the genus would, therefore, not only be cumbersome, but out of place in a work of this kind. Much of this information does not relate to taxonomy or distribution, while that which does is admirably summarised by Patterson and Stone in their recent book, "The Evolution of the Genus Drosophila". In addition, the intention of this work is to extend the knowledge of Drosophila taxonomy and ecology, rather than recapitulate the conclusions arrived at by other workers in this field. The relevant literature is, however, referred to and discussed in the following chapters, and an attempt is made to relate new information to that of other workers. The methods adopted in this work were chosen to allow a comparison of the results with those of Burla, Dobzhansky, Patterson, and the other authors cited.

CHAPTER II
TAXONOMY OF THE BRITISH SPECIES
OF DROSOPHILA

Taxonomy of the Genus

Present day work on the taxonomy of the genus Drosophila expresses general agreement on the limits and subdivisions of the genus. Patterson, Wheeler, Spencer, Stone, Dobzhansky, Epling and other workers in the United States, as well as Burla, Hadorn, Gloor, and other workers in Europe, all follow the classification outlined by Sturtevant (1942: 27-32), a classification which attempts to reflect the genetic relationships between species. It is based on 27 different characters, internal as well as external, and concerning eggs, larvae, pupae, and imagines, all studied alive.¹ Later authors have added two more subgenera (for complete list of subgenera, see pages 18-22) which include some North American and Mexican species. This more recent classification differs considerably from that outlined by Duda (1924a: 172-234, 1924b: 247-313, 1935: 47-101), which is based primarily on external characteristics of dried flies, since Duda studied museum material.

Duda's classification is given below. The diagnoses of the subgenera are not given either in the revision of the genus (1924b) or in the more recent paper on palaearctic Drosophila (1935), but there is an extensive key to the subgenera, from which I have extracted the following diagnoses. Duda gives an extensive definition of the genus Drosophila, as he delimits it (1924a: 198-202), which I have not reproduced here.

1. Sturtevant (1939: 138-139) outlines how these characters were chosen.

Subgenus Incisurifrons Duda

The distal section of the 4th vein or almost 4 times as long as the 3rd section. 2nd section of the costal vein only $1\frac{1}{2}$ to $1\frac{1}{4}$ as long as the 3rd. Carina high, "rams nose"-shaped, without the appearance of an upper lip of a face (Gesichtsoberlippe) falling away at the border of the mouth. Forehead anteriorly deeply notched, and therefore anteriorly almost twice as wide as medially long, posteriorly over twice as wide as medially long. Proclinate orbital inserted near the anterior margin of the forehead. Thorax reddish yellow. Abdomen brown to black, without other colored spots or bands. Ovipositor lamellae of the female hidden

D. congesta Zett.

D. nigriventris Zett.

Subgenus Acanthopterna Duda = Spinodrosophila Duda

Distal section of the 4th vein 1 - $2\frac{1}{2}$, exceptionally 3 times as long as the 3rd section; in the last case, the 2nd section of the costal vein is almost 2 - $2\frac{1}{2}$ times as long as the 3rd and the carina is nasiform, underneath with the appearance of an upper lip of a face, falling away to the rim of the mouth. Forehead not very extensive. Proclinate orbital generally inserted shortly anterior to the middle of the forehead. Arista not apically forked, underneath with only one long basal branch, above with two basal branches, otherwise only with fine, short hair. Long distance between the dorsocentrals over $1/2$ as long as their lateral distance. 3rd metatarsus of the male ventrobasally with a conspicuous strong thorn.

* D. nigrosparsa Strobl

Subgenus Acrodrosophila Duda

Distal section of the 4th vein 1 - 2½ as long as the 3rd section; and the 2nd section of the costal vein is about 2 - 2½ times as long as the 3rd. The carina is nasiform and deep reaching. Forehead not very extensive. Proclinate orbital generally inserted shortly anterior to the middle of the forehead. Arista with an apical fork. Long branches, basal to the end-fork, above and below on the distal part of the arista. 3rd metatarsus of the male never with a ventral basal thorn. Anterior to the transverse suture are a pair of small, black acrostichal macrochaetae. Mesonotum shining reddish yellow, with 6 rows of acrostichal hairs. Abdomen yellow, with a medially interrupted black band on the posterior margin, which is straightly bordered anteriorly. Wings colourless. Anterior and posterior transverse veins not shaded.

♂
X D. testacea v. Ros.

Subgenus Acanthophila Duda (= Spinulophila Duda)

Distal section of the 4th vein 1 - 1½ times as long as the 3rd section; the 2nd section of the costal vein is almost 4 times as long as the 3rd. The carina is strong and nasiform.

Forehead not very extensive. Proclinate orbital generally inserted shortly anterior to the middle of the forehead. Arista with an apical fork. Long branches, basal to the end-fork, above and below on the distal part of the arista. 3rd metatarsus of the male never with a ventral basal thorn. No acrostichal macrochetæ anterior to the transverse suture. 1st femor anteroventrally with a dense series of small black bristles. Mesonotum of the single palæarctic species, D. immigrans Sturtev., yellowish brown, with 8 rows of acrostichal hairs. 1st metatarsus of the male ventrally with thick, brush-like hairs along the whole length.

* D. immigrans Sturtev.
x

Subgenus Parascaptomyza Duda

Distal section of the 4th vein $1 - 2\frac{1}{2}$, exceptionally 3, times as long as the 3rd section; in the last case, the 2nd section of the costal vein is almost $2 - 2\frac{1}{2}$ times as long as the 3rd and the carina is nasiform, underneath with the appearance of an upper lip of a face falling away to the rim of the mouth. Forehead not very extensive. Proclinate orbital generally inserted shortly anterior to the middle of the forehead. Arista with an apical fork: long branches basal to the end fork above and below on the distal part of the arista. 3rd metatarsus of the male never with a ventral basal thorn. No acrostichal macrochetæ anterior to the transverse suture.

1st femur anteroventrally without a dense series of small black bristles. Only one strong humeral present, the lower one being minute, and only two rows of acrostichal hairs. Mesonotum usually all matt, or at least with matt hairiness between the acrostichal hairs; anal lamellae of the male and ovipositor lamellae of the female rudimentary.

D. disticha var. flava (Meig.)
Beck.
disticha var. gracilis (Walk)
Beck.
disticha Duda typica

Subgenus Scaptomyza Hardy

Distal section of the 4th vein 1 - 2½ times as long as the 3rd section. Forehead not very extensive. Proclinate orbital, generally inserted shortly anterior to the middle of the forehead. Arista with an apical fork: long branches, basal to the end-fork, above and below on the distal part of the arista. 3rd metatarsus of the male never with a ventral basal thorn. No acrostichal macrochaetae anterior to the transverse suture. 1st femur anteroventrally without a dense series of small black bristles. Two humeral bristles present, the under one usually at least 1/2 as long as the upper one. Mesonotum matt, usually with a median dark brown longitudinal stripe. Only 2 to 4 rows of

acrostichal hairs. Anal lamellae of the male and ovipositor lamellae of the female strongly developed.

D. subsplendens Duda
apicalis Hardy
graminum Fall.
unipunctum Zett.

Subgenus Dasydrosophila Duda (Sturtevant, 1942: 27 = Hirtodrosophila Duda)

Distal section of the 4th vein 1 - 2½ times as long as the 3rd section. Forehead not very extensive. Proclinate orbital generally inserted shortly anterior to the middle of the forehead. Arista with an apical fork: long branches, basal to the end, above and below on the distal part of the arista. 3rd metatarsus of the male never with a ventral basal thorn. No acrostichal macrochaetae anterior to the transverse suture. 1st femur anteroventrally without a dense series of small black bristles. Two humeral bristles present, the lower one usually at least 1/2 as long as the upper one. Mesonotum more or less shining, if matt and with a median dark longitudinal stripe, then with more than 4 rows of acrostichal hairs. 3rd antennal segment very large (about 3 times as long as the 2nd segment)

and with conspicuous long hair. Carina usually flat, not nasiform. Only the 3rd tarsus with a clear preapical bristle.

D. Lundstroemi Duda (Finland.)
Oldenbergi Duda (Hungary.)

Subgenus Drosophila Fall. sens. str.

Distal section of the 4th vein $1 - 2\frac{1}{2}$, exceptionally 3 times, as long as the 3rd section; in the 1st case, the 2nd section of the costal vein is almost $2 - 2\frac{1}{2}$ times as long as the 3rd section and the carina is nasiform, underneath with the appearance of an upper lip of a face, falling away to the rim of the mouth. Forehead not very extensive. Proclinate orbital generally inserted shortly anterior to the middle of the forehead. Arista with an apical fork; long branches basal to the end of the fork above and below on the distal part of the arista. 3rd metatarsus of the male never with a ventral basal spine. No acrostichal macro^achaetae anterior to the transverse suture. 1st femor anteroventrally without a dense series of small black bristles. 2 humeral bristles present, the under one usually at least $1/2$ as long as the upper. Mesonotum more or less shining, if matt and with a median dark long stripe, then with more than 4 rows of acrostichal hair. 3rd antennal segment small (at most twice as long as the 2nd antennal segment) and with shorter hair, if exceptionally large and longly haired, the carina is nasiform. The 1st, 2nd and 3rd tarsi with clear dorsal preapical

bristles.

- * D. brevicornis Duda (Siberia)
 X Bugcki Coqu.
 * deflexa Duda
 * = D. guyenoti Burks (1948)
 X fasciata Meig.
 * fenestrarum Fall.
 X funebria Fabr.
 * histris Meig.
 * Kuntzei Duda
 X limbata v. Res.
 * littoralis Meig.
 X macularis Villen.
 * Miki Duda (Austria)
 * nigricolor Strobl
 X obscura Fall.
 * (= D. obscuroides Pomini
 1940)
 * palida Zett.
 * phalerata Meig.
 X Pokornyi Duda (Tyrol)
 * reperta Wollast.
 X rufifrons Loew.
 * (= D. nitens Buzzati 1943)
 * scaptomyzoptera Duda
 (Siberia)
 * Schmidtii Duda (Hungary)
 * Stackelbergi Duda (Siberia)
 X transversa Fall.
 * trivittata Strobl. (Europe,
 Siberia, Formosa, Java)
 * unimaculata Strobl.
 X vibrissina Duda

Described by Becker (1905: 219-222) but not discussed by Duda

D. cadnerella Fall.

D. litorella Meig

D. nitidapex Bigot. (Canary Islands)

D. varipes Macp. (Duda, because of ^{the} color description, does not believe it is a Drosophila)

* Included in Burla's check list of Swiss Drosophila (1951: 37)

x Drosophila included in Kloet and Hincks (1945: 401; 433)

Though Duda's specific descriptions are extensive and accurate, his subgenera seem to segregate out conspicuous characteristics rather than natural groups, and it is not surprising that Sturtevant, in his more natural classification, retains only two of Duda's eight groups.

Two of Duda's subgenera, Acrodrosophila and Acanthophila (= Spinophila Duda) are based on single characters, as already pointed out by Sturtevant (1939: 140), and one other, Acanthoptera, includes only one species, D. nigrosparsa², which is separated on the basis of a long ventrobasal spine on the 3rd metatarsus of the male. Burla, in his classification of the Swiss Drosophila, omits this subgenus, and includes D. nigrosparsa in the "as yet unclassified" group of species. In addition, Duda includes Scaptomyza, described by Hardy (1849: 361) as a separate genus, as a subgenus of Drosophila, and adds a closely related

2. Does not occur in England

group, Parascaptomyza, as another subgenus. Though Duda explains and defends this classification (1935: 55-58) it is not accepted by any of the above mentioned workers in the field, who consider Scaptomyza and Parascaptomyza as separate genera (Sturtevant, 1942: 24-25). Since the relative ranking of groups above the level of species is a matter of taste, it seems best to follow the general practice and exclude the above two groups from the genus Drosophila. Yet another of Duda's subgenera, Incisurifrons, contains two species, of which one, D. congesta, has been removed from the genus (Patterson and Stone, 1952: 7). The other species of the subgenus has not been recently discussed. D. cinerella Fallén has also been removed from the genus (Patterson and Stone, 1952: 7).

Duda's classification of European Drosophila is the most comprehensive, including all the palaeartic material known to him; however the subsequent classification of Burla (1951) is more thorough, being based on characteristics of eggs, larvae, and pupae as well as imagines, and including a number of species described since Duda's paper (D. simulans, D. subobscura, D. bifasciata, D. ambigua, D. alpina, D. helvetica, and D. obscura-X³.)

The generally accepted definition of the genus Drosophila is: small acalypterate flies with the following

3. A species still to be validly named by Basden (1952: 200).

characteristics ⁴.

"Arista plumose; vibrissae and ocellars present; three orbitals, lower-most proclinate, upper two reclinate, middle one smaller than the other two (second placed a trifle below the third in D. alabamensis); postverticals large; one or more humerals; one presutural; two notopleurals; two supra-alars; two postalars; one to three sternopleurals; mesopleurae bare; two dorsocentrals*; prescutellars usually absent (present in D. sigmoides, D. floriae and species similar to each, represented by large hairs in D. repleta and other forms); two pairs of scutellars, posterior ones crossed; disc of scutellum bare; costa twice broken, reaches apex of fourth vein; two small bristles just before distal costal break; discal and second basal cell confluent; anal cell present, often incomplete; preapicals evident at least on third tibiae; aerostichal hairs in six or more rows in front of transverse suture, four or more between the anterior dorsocentral bristles." (Patterson, 1943: 46).

Burla follows Sturtevant in his reclassification of the European species of the genus Drosophila, which is as follows⁵

-
4. Diagrams of the characters used can be found in Demerec and Kaufmann (1945) or Burla (1951)
5. Descriptions of the species-groups found in England will be given following the key. Subgeneric descriptions are almost all quoted from Sturtevant (1942), but note is made where they differ seriously from those of other authors.
- * Three dorsocentrals in the polychaeta group.

(I have modified it to include all British species, and two more subgenera, which have been recently described).

<u>Subgenus</u>	<u>Species-group</u>	<u>Species</u>
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<u>Hirtodrosophila</u>	Duda (synonym <u>Dasydrosophila</u> Duda)	
------------------------	-------------------------------------------	--

"Third antennal segment large, covered with unusually long hairs. Carina narrow, short, practically absent on lower part of face. Arista usually with one branch below in addition to terminal fork. Sterno-index .5 or less. So far as known, all are fungus-feeders." (Sturtevant, 1942: 27-28)⁶

Pholadoris Sturtevant

Dark species. Prescutellars present. Egg filaments 4 to 6. Posterior Malpighian tubes apposed on the distal ends. Testis short, not coiled. Ventral receptacle short, not coiled. (translated from Burla, 1951: 70, who omits some of the characters used in Sturtevant's definition of the subgenus in order to include the following two species. Wheeler, 1949a: 148-154, gives a more extensive description of the subgenus and does not believe D. guye-noti belongs in it.)

D. nitens
(synonym for D. rufifrons)
D. guyenoti
(synonym for D. deflexa)

6. Duda's two species from Eastern Europe, D. Lundstroemi and D. Oldenbergi, belong in this subgenus.

Subgenus Dorsilopha Sturtevant

"Yellowish species, mesonotum longitudinally striped; pre-apicals not evident on the second and third tibiae; larvae with dorsal processes; 4 egg filaments; posterior Malpighian tubes fused; ventral receptacle not kinky; sterno-index about 0.3". (Sturtevant, 1942: 28)

D. busckii

Subgenus Phloridosa Sturtevant

"Shining black or brown species; bristles and branches of arista short; sterno-index .3 or less; anterior Malpighian tubes absent; posterior Malpighian tubes fused to form a loop around the gut; testes long, spirally coiled; eggs without filaments or remains of follicle cells; flower-feeding species." (Sturtevant, 1942: 28)

Subgenus Siphodora, Patterson and Mainland

"This subgenus includes yellowish brown species with pre-scutellar bristles present, arista with eight branches, posterior cross veins distinctly sinuate, testes coiled, ventral receptacle loosely coiled or looped, and two-filament eggs". (Patterson and Stone, 1952: 13)

Subgenus Sordophila, Wheeler

"This subgenus includes yellowish species with two-filament eggs expanded at tip, ventral receptacle long and tightly

coiled, spermathecae thin-walled without sclerotized centers, testes composed of a moderate number of coils, acrostichal hairs in six rows and with no prescutellar bristles present."

(Patterson and Stone, 1952: 14) -----

Subgenus Sophophora Sturtevant

"Eggs with 2 blunt filaments; ventral receptacle not kinky; posterior Malpighian tubes free at their distal ends; sterno-index 0.6 or less; anterior spiracle and its stalk not over 1/5 of the length of the puparium; second to fifth abdominal tergites with posterior dark bands that are never broken or narrowed in the mid-dorsal line; cheeks always relatively narrow." (Sturtevant, 1942: 28)

saltans group -----

willistoni group -----

melanogaster group D. simulans
D. melanogaster

obscura group D. subobscura
D. obscuroides
(synonym for D. obscura)

x D. bifasciata

D. ambigua

D. tristis

x D. alpina

D. obscura-X

D. helvetica

alagitans group -----

nannoptera group -----

bromeliae group -----

Drosophila Fallén

"Three or four egg-filaments (two in the melanica group), at least anterior ones tapering; ventral receptacle long, fine, usually kinky; testes long, spiral; posterior Malpighian tubes forming a closed loop around the gut, their distal end sometimes merely opposed, but usually fused and with a continuous lumen; dark posterior bands on the abdomen usually narrowed or broken in the mid-dorsal line; sterno-index usually .5 or more; cheeks often wide; puparial "horns" often more than 1/5 of the length of the puparium" (Sturtevant, 1942: 30)

quinaria group	<u>D. transversa</u>
	<u>D. kuntzei</u>
	<u>D. phalerata</u>
	<u>D. limbata</u>
guttifera group	-----
virilis group	<u>D. littoralis</u>
	x <u>D. unimaculata</u> 7.
testacea group	<u>D. testacea</u>
tripunctata group ⁸	-----
funebria group	<u>D. funebria</u>
repleta group	<u>D. repleta</u>
	<u>D. hydei</u>

7. Patterson and Water doubt that D. unimaculata belongs to the virilis group, and believe it to be nearer the melanica group (Burla 1951: 107)

8. D. histrio was originally believed to be a possible member of this group, but a comparison of the male genital arch and the female ovipositor lamellae show no particular relationship to D. tripunctata (Burla 1951: 123)

robusta group	-----
melanica group	x <u>D. tsigina</u> ^{9.}
polychaeta group	-----
carbonaria group	-----
immigrans group	<u>D. immigrans</u>
macroptera group	-----
ribrifrons group	-----
annulimana group	-----
melanderi group	<u>D. pallida</u> ^{9.} (called <u>D. cameraria</u> by British dipterists)
bizenata group	-----
guarani group	-----
pallidipenis group	-----
dreyfusi group	-----
Not classified	<u>D. histrio</u>
	<u>D. fenestrarum</u>
	xx <u>D. acuminata</u>
	xx <u>D. forcipata</u>
	xx <u>D. vibrissina</u> 10.
	x <u>D. nigrosparaa</u>
	xx <u>D. macularis</u>

9. Burla and Gloor (1952)

10. In the subgenus Drosophila, but not placed in a species group (Sturtevant, 1942)

x Found in Switzerland, not England
xx Found in England, not Switzerland.

I have added four species (xx) which occur in England (and apparently not in Switzerland) to Burla's classification, and five (x) of Burla's species have not been found in Britain. The species groups are defined largely in terms of internal characteristics, and characteristics of the eggs, larvae, and pupae, so that unless there are a large number of representatives of a species, or it is easy to breed, it is impossible to determine exactly its position in the classification. The same holds true, only to a lesser extent, for the subgenera. All the species I have added, therefore, I have listed as 'unclassified'. All the species which Burla did not find in Switzerland occur only rarely in England.

A total of 28 species of Drosophila have been reported from Great Britain, namely:

D. rufifrons, D. deflexa, D. busckii, D. melanogaster, D. simulans,
D. subobscura, D. obscura, D. ambigua, D. tristis, D. helvetica,
D. obscura-X, D. transversa, D. kuntzei, D. phalerata, D. limbata,
D. littoralis, D. testacea, D. funebris, D. repleta, D. hydei,
D. immigrans, D. histrio, D. fenestrarum, D. acuminata, D. forcipata,
D. pallida, D. vibrissina, D. macularis. The list differs considerably from that published by Kloet and Hincks (1945:401:433) since these authors use Duda's classification, and include a number of species now not considered to be Drosophila; and several new species have been added to the check list since 1945 (Basden, 1952; Collin, 1952). Of the 28 species, I have found 22 in my collecting.

Since Burla (1951) did such excellent descriptions of most of the species, and Duda (1935) also did careful descriptions, particularly of the position and length of the bristles, I shall not add to the number of authors a prospective Drosophila worker will have to compare. Following the key to the British species are references to the various descriptions, and a discussion when the specimens I have collected do not agree with the descriptions of the other authors. Duda's descriptions tend to be more complete on external characteristics; whereas Burla's descriptions do not give as much detail of external morphology, but include internal characteristics and wing indices, and follow the pattern set out by Sturtevant, Patterson and Wheeler, and other workers in the United States.

In the discussions and descriptions, I have used the terminology outlined by Sturtevant (1942: 7-21) and followed by Burla and other workers in the field. Most of these characters seem reasonably constant between individuals of a species. However, I find wing indices (given in most descriptions as an approximate measurement) are quite variable. Measuring 20 wild D. subobscura individuals from different localities, 10 males and 10 females, I got the following range of variation with respect to the 4 wing indices

	range	average	Burla's figures
Costal	2.4 - 3.4	2.7	2.4
4th vein	1.8 - 2.1	2.0	1.9
5x	1.7 - 2.0	1.8	1.7
4c	0.7 - 1.1	1.0	1.0

About this amount of variation is characteristic of all the members of the obscura group (comparable measurements were made for the 5 other British species) and is not confined to members of this group, as is shown by the measurements of 5 individuals of the species D.littoralis, in the victoria group

	I.	II.	III.	IV.	V.	Av.	Burla
4th vein	1.5	1.5	1.7	1.7	1.8	1.7	1.5
5x	1.2	1.1	1.1	1.4	1.3	1.2	1.2
costal	3.1	3.4	3.0	2.8	3.0	3.1	3.2
4c	0.7	0.7	0.8	0.8	0.9	0.8	0.7

Even Sturtevant (1921) and Patterson (1942) differ in the wing indices they give for the same species, for instance

D.repleta

	Sturtevant	Patterson
4th vein	3.4	3.0
5x	1.8	1.7
costal	1.3	1.4
4c	0.9	0.86

This indicates that, though it is a useful indication of the general shape of the wings, the wing index measurement should be used with care. On the following brief species-descriptions, my wing index measurements sometimes differ from those of Burla (1951); in such cases, they are starred (*). Unless my measurements differed considerably, I used those recorded by him. It is possible that these differences reflect different measuring techniques rather than true differences between British and Swiss representatives of the same species.

Wide variability in color and the very inconspicuous morphological differences between many closely related species make it difficult to construct a key to the genus Drosophila. Duda (1935) uses characteristics which are not at all obvious unless one has had a great deal of experience in dealing with Diptera. For this reason, his key is not very satisfactory. Burla's key (1951: 66-69) is much easier to use. It is sometimes misleading, however, since he often makes use of single variable characters for separation. For example, in species with a yellow mesonotum (one of Burla's key characteristics) occasionally individuals are blackish brown. Moreover, neither key includes all the species found in Great Britain.

I have tried to make the following key sufficiently comprehensive to make possible the identification of an unknown species with certainty (even though I do not give a complete description). Species difficult to identify are not separated in the main key, but discussed in the section which follows and two species, D. immigrans and D. histrio, are included under two sections of the key, since the shading of the cross-veins of these two species is not always distinct. The following species, although on the British check list, I have not collected: D. testacea, D. repleta, D. simulans, D. fenestrarum, D. acuminata, and D. macularis. Of these, the first three species were studied from live stocks and specimens preserved in alcohol;

the last three are included in the key on the basis of descriptions by other authors. Following the key are references to complete descriptions of the various species. Duda (1935) gives a complete list of references and synonyms for all the species of Drosophila he describes, so I shall only discuss the type descriptions and the more recent works, primarily Duda (1935) and Burla (1951). Duda and Burla often differ in their measurement of cheek width, since Duda usually gives the measurement of the cheek at the lowest border of the eye, whereas Burla always gives the width at the lower posterior angle of the cheek (Burla 1951: 58). In other respects, Burla's account is usually based on that of Duda. I have indicated where the descriptions differ in important respects.

Seguy (1934: 368-389) gives a key and descriptions of the Drosophila of France. He includes only 12 of the 28 species found in Great Britain, the descriptions are too brief to be useful, and the key is inaccurate. For instance, D. tristis is described in the key as having brown along the edge of the costal vein, whereas in fact only the males of D. tristis have darkened wings. Again, neither the key nor the description of D. busckii refers to the very characteristic pattern of thoracic markings of this animal. Furthermore, Seguy includes D. guinaria Loew in his key, and this species occurs only in the Nearctic region (Patterson and Stone 1952: 55). D. fasciata Meigen is also included, but it is difficult from Seguy's description

to know which species is being referred to. (Duda believes D. fasciata Meigen to be the species now generally called D. melanogaster, but Seguy also includes this species in his key and description.) This work is of very little value for the identification of the Drosophila in Great Britain, and for this reason, no reference is made to it in the following section. What little value it possesses is due to the wider currency which French, as opposed to German, texts have in England, since in every way both Burla and Duda are far superior. It may be convenient, however, simply to list the species with which Seguy deals: D. phalerata, D. transversa, D. busckii, D. repleta, D. obscura, D. tristis, D. melanogaster, D. simulans, D. funebris, D. fenestrarum, D. histrio, and D. immigrans.

Illustrations of the characters used in the key may be found in Burla (1951: 57 - 64) or Demerec and Kaufmann (1945: 16-18).

KEY TO THE SPECIES OF DROSOPHILA

1. a. Both the anterior and the posterior cross-veins, or at least the posterior one, darker than the long veins, and/or clearly shaded with grey or black.....2
- b. Cross-veins not, or scarcely noticeably, darkened...4
2. a. Mesonotum reddish brown. Pleurae reddish brown, extensively suffused with blackish grey. Abdominal tergites blackish brown, without pattern. Posterior cross-vein sometimes darker, and always shaded with brown; anterior cross-vein sometimes so. Two equally strong bristles anterior to the distal break in the costal vein. (♀ 3.6-4.3 mm. ♂ 3.0-3.9 mm. Arista with 7-8 branches including the end fork. Carina wide, nasiform, medially grooved. Palps with one long terminal bristle, and numerous shorter ones. 6 rows of acrostichal hairs. Abdominal sternites large, dark. Wing surfaces grey. Wing indices: 3.2; 1.5; 0.7; 1.2¹¹).....D. littoralis (p. 85)
- b. Mesonotum yellow to yellowish brown.¹² Pleurae yellow to yellowish brown, not striped. Abdominal tergites yellow with black bands on the posterior margin which are medially inter-
11. Wing indices given in the following order: costal index (length of the 2nd section of the costal vein/length of the 3rd), 4th vein index (length of the distal, 4th, section of the 4th vein/length of the 3rd section), 4 c index (length of the 3rd section of the costal vein/length of the 3rd section of the 4th vein) and 5 x (length of the distal section of the 5th vein/length of the posterior transverse vein).
12. Occasionally, very dark individuals of these species occur with a blackish brown mesonotum.

rupted and sometimes broken into spots. Both the anterior and posterior cross-veins darker, and extensively shaded with black (sometimes grey). 2 equally long bristles anterior to the distal break in the costal vein. (Carina nasiform. Palps with one to several long bristles, and numerous shorter ones which are very irregularly placed).....guinaria group (p. 76)

c. Mesonotum yellow to yellowish brown, occasionally with diffuse longitudinal stripes. Pleurae yellowish brown, uniformly colored. Abdomen with clearly separated triangular spots, or bands on the posterior margin of the tergite which are interrupted medially and laterally narrowed. Cross-veins (or sometimes only the posterior one) narrowly shaded with grey. 1 strong bristle anterior to the distal break in the costal vein (and sometimes a second weak one).....3

d. Mesonotum dull yellow. Pleurae with two blackish horizontal stripes. Abdomen with four rows of black spots, the median ones form large spots, sometimes merging. Posterior cross-vein very darkly, and narrowly, shaded.....D.macularis (p.101)

3. a. Inside the femur of the anterior leg, a row of very short, sharp black bristles (fig. II-1) (♀ 3.5-4.3 mm; ♂ 2.6-3.7 mm. Arista with 9-12 branches including the end-fork. Carina broad, flat. 2nd oral bristle almost as long as the 1st. Palps with

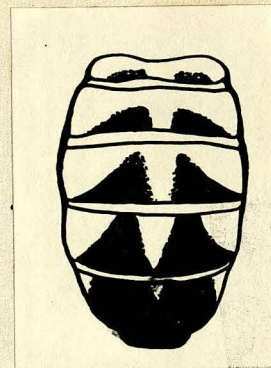
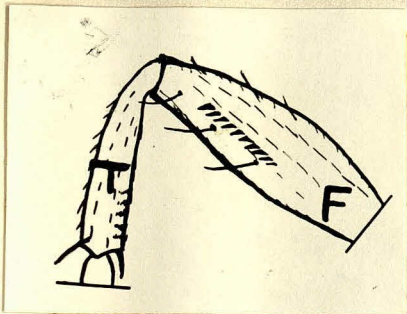


Fig. II-1. The inside of the femur of the anterior leg of D. immigrans. F is the femur; T is the tibia

Fig. II-2. The abdominal pattern of the δ of D. immigrans. ♀ quite similar

the male shorter and thicker than that of the posterior leg, and with yellow, brush-like hairs. 8 rows of acrostichal hairs.

Abdomen as in fig. II-2¹³. 1 bristle anterior to the distal break in the costal vein. Only the distal cross-vein, as well as the distal end of the 2nd and 3rd longitudinal vein, shaded. Wing indices: 4.4; 1.2; 0.5; 1.0).....D. immigrans (p. 95)

b. Inside the femur of the anterior leg without a row of short black bristles. (♀ 4.0 - 4.8 mm; δ 3.8 - 4.4 mm. Arista with 9 - 11 branches including the end-fork. Carina nasiform. 2nd oral bristle $1/2$ - $2/3$ the 1st. Palps with 2 - 3 bristles on the under side. 2 long sterno-pleural bristles, the 3rd

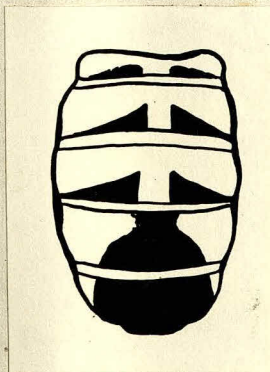


Fig. II-3. The abdominal pattern of the δ of D. histrio ♀ quite similar

about $1/4$ the length of the longest. 1st tarsal segment of the anterior leg not shorter and thicker than those of the posterior legs. 8 rows of acrostichal hairs. Abdomen as in fig. II-3. 2 bristles anterior to the distal

¹³. The spots do not always extend so far toward the anterior margin of the tergite.

break in the costal vein, the more basal one considerably weaker (sometimes absent). Both the anterior and posterior cross-veins darker, and slightly shaded. Wing indices: 3.7 - 4.4; 1.5 - 1.9; 0.6 ± 1.0 - 1.2).....D. histrio (p. 98)

4. a. With 4 irregular rows of acrostichal hairs between the dorsocentrals: 6 anterior to the dorsocentrals. (Arista with about 8 branches including the end-fork. Carina weakly developed, not nasiform. Mesonotum yellow to yellowish brown. Abdominal tergites variously colored).....fenestrarum group (p. 102.)

b. 6 - 8 regular rows of acrostichal hairs between the dorsocentrals......5

5. a. Arista with only 1 branch underneath, proximal to the end-fork. (♀ about 3.6 mm; ♂ about 3.0 mm. Arista with about 7 branches including the end-fork. Carina nasiform. Palps club-shaped, above with a medium strong apical bristle and underneath usually with a weaker subapical and fine, short hair. Mesonotum matt yellowish brown, often with darker, diffusely edged, longitudinal stripes. 6 rows of acrostichal hairs. Abdomen variably colored, sometimes uniform yellowish brown, sometimes wide or narrow blackish bands on the posterior margins of the tergites which are medially narrowly interrupted. Ovipositor lamellae of the female distinctly blackish. Wing indices: 3.2 - 3.8; 1.4 - 1.6; 0.7; 1.5).....P. cameraria (p. 96)

- b. Arista with more than one branch underneath, proximal to the end-fork.....6
6. a. 2 enlarged bristles between the rows of acrostichal hairs on the anterior third of the mesonotum (anterior to the transverse suture). (♀ 2.6 - 3.9 mm ♂ 2.5 mm. Arista with 7-10 branches including the end-fork. Carina nasiform. Palps spoon-shaped, with equally strong bristles apically and underneath. Mesonotum yellow to dark brown. 6 rows of acrostichal hairs. Abdominal tergites yellow with a black band on the posterior margin which is straightly bordered anteriorly and medially interrupted (widely anteriorly; narrowly posteriorly). Wing indices: 2.8-3.3; 1.5-2.0; 0.9-1.4; 1.2- 1.7).....D.testacea (p.⁴⁴)
- b. No enlarged bristles on the anterior third of the mesonotum.....7
7. a. Dark species, reddish brown to black.....8
- b. Yellow to light yellow brown species¹⁴.....9
- c. Greyish species with each hair and bristle arising from darker spots (which merge on the mesonotum, giving a blotchy appearance). (♀ about 3.4 mm; ♂ about 3.0 mm. Arista with 7-8 branches including the end-fork. Carina nasiform, medially grooved. Palps with several almost equally strong bristles
-
14. D.macularia is described as yellowish brown, and keyed under 9

apically and on the under margin. Abdominal tergites with black bands on the posterior margin which are medially interrupted

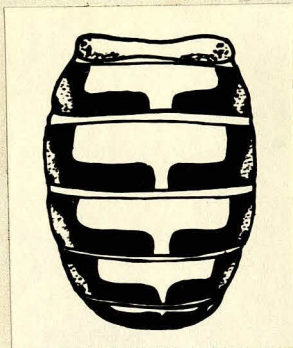


Fig. II-4. The abdominal pattern of D. repleta

rupted and become wider laterally, reaching the anterior margin of the tergite; more-or-less clear, irregular yellow spots on the lateral margin of the tergites. Fig. II-4.....
repleta group (p. 86)

8. a. Mesonotum black, blackish brown (sometimes greyish), or occasionally dark yellowish brown, sometimes with longitudinal stripes. No enlarged prescutellar acrostichal hairs. Palps pale yellow, with 1, or at the most 2, long bristles, and very few shorter ones. (♀ 2.3 - 3.8 mm; ♂ 1.9 - 3.1 mm.¹⁵ Arista with 6 - 8 branches including the end-fork. Forehead becoming some-

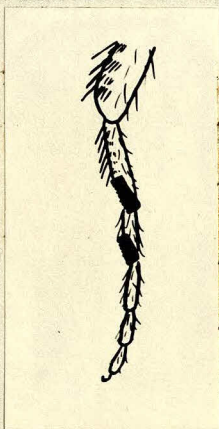


Fig. II-5. The sex combs on the 1st and 2nd tarsus of the anterior leg of D. subobscura ♂

what wider posteriorly. Carina nasiform, sometimes only in the upper half of the face. 6 - 8 rows of acrostichal hairs. 1st and 2nd tarsal segment of the anterior legs of the males with combs of two to many peg-like bristles (fig. II-5). Abdominal tergites shining black or

brown, sometimes with yellow patches on the lateral margins.

15. Occasionally, dwarf individuals of this species are found.

Anal plates of the males without peg-like bristles. Ovipositor lamellae of the female widely or narrowly rounded apically with black bristles on the apex (inconspicuous in D. helvetica, which has a brown ovipositor lamella margin) Wing surfaces colorless to slightly grey; veins yellow to yellow brown)....
obscura group (p. 49)

b. Mesonotum brown to blackish brown. 2 enlarged prescutellar acrostichal hairs. Palps yellow to brown with several strong bristles on the margin, becoming weaker basally. (♀ about 2.0 mm; ♂ about 2.6 mm. Arista with 6 - 8 branches including the end-fork. Forehead almost equally wide anteriorly and posteriorly. Carina basally widened and bulbous in shape. 6 - 8 rows of acrostichal hairs. Males without sex-combs on the anterior tarsus. Abdominal tergites brown to blackish brown. Anal plates of the male without peg-like bristles. Ovipositor lamellae of the female narrowly rounded apically, with conspicuous dark yellowish brown bristles.....subgenus Pholedoris (p. 39)

c. Mesonotum reddish or greyish brown, unstriped. No enlarged prescutellar acrostichal hairs. Palps yellow with about 3 rather strong bristles underneath, and numerous irregularly placed weaker ones. (♀ about 3.5 mm; ♂ about 3.3 mm, - but there is a great amount of variability in size. Arista with 10 - 12 branches including the end-fork. Forehead becoming wider posteriorly. Carina strong, nasiform, flattened.

8 rows of acrostichal hairs.

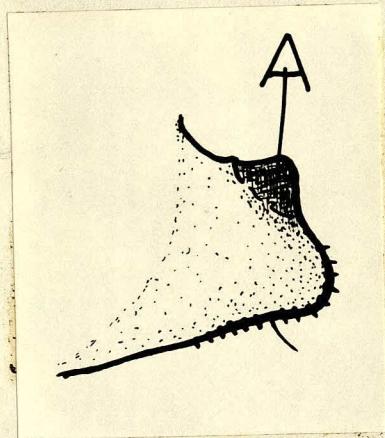


Fig. II-6. Left ovipositor lamella of *D. funebris* ♀

Several enlarged hairs anterior to the dorsocentrals. Males without sex-combs on the anterior tarsus. Abdominal tergites with black bands on the posterior margin of the tergite which are more-or-less completely interrupted medially at least on the anterior tergites. Anal plates of the male

with numerous conspicuous peg-like bristles. Ovipositor lamellae of the female without conspicuous bristles, with a dark reddish brown projection on the dorsal edge (fig. II-6A) Wing surfaces colorless; veins brown. Wing indices: 3.4; 1.4; 0.6; 1.1)....
*D. funebris*(p. 92)

9.a Thorax with three narrow black stripes (the lateral two along the dorsocentral line: the median one forked), and two lateral ones, which run from the humeri to above the root of the wing. (about 2 mm. Arista with about 9 branches including the end-fork. Carina high, slightly flattened. 8 rows of acrostichal hairs. Pleurae pale yellow, with two reddish-brown stripes running forward, one from the base of the wing; the other from just below; and a spot on the sternopleura. Abdomen yellow;

tergites with black bands on the posterior margin which are interrupted in the mid-line and narrowed, or sometimes interrupted, laterally between the mid-line and the lateral margin of the tergite. Wing indices: 3.1; 2.1; 1.9; 1; 0)

.....D. busckii (p. 43)

b. Thorax not clearly striped, or at most, with a median brownish stripe.....10

10. a. Inside the femur of the anterior leg, a row of very short, sharp black bristles (fig. II-1).....D. immigrans (see 3a)

b. Inside the femur of the anterior leg without a row of short black bristles.....11

11. a. Abdominal tergites yellow with black bands on the posterior margin which are not broken into spots.....12

b. Abdominal tergites yellow; on the 2nd - 6th tergites, 4 black spots and one central narrow black longitudinal stripe. (Arista with about 10 branches including the end-fork. Carina nasiform. 6 rows of acrostichal hairs. Mesonotum yellowish brown. Pleurae yellow, with a brown longitudinal stripe. Wing indices about 2.5 - 3.0; 1.2-1.5; (no 4 e given); 1.0 - 1.1.D. macularis (p. 40))

c. Abdominal tergites all black, or with black bands on the posterior margin of the tergite which are not medially interrupted. (About 2 mm. Arista with about 9 branches including the end-fork. Carina rather wide, flat. Mesonotum shining reddish yellow, occasionally with a medial longitudinal stripe which becomes wider between the dorsocentrals. 8 rows of acrostichal hairs. 1st tarsal segment of the male with a comb of peg-like bristles. Wing indices about 2.2; 2.4; 2.4^{*}; 1.3)..
melanogaster group (p. 45)

12. a. Large species (♀ 4.0 - 4.8 mm; ♂ 3.8 - 4.4 mm.) Mesonotum yellowish brown. 2nd - 4th abdominal tergites with triangular spots widely separated medially (fig. II-3)....D. histrio (see 3b)

b. Large species (♀ about 3.9 mm; ♂ about 3.3 mm.) Mesonotum yellow, occasionally with indistinct longitudinal stripes. 3rd-5th tergite with a black band on the posterior margin which is straight anteriorly and narrowly interrupted medially.¹⁶ (Arista with 9 - 11 branches including the end-fork. Palps with a moderately strong apical bristle, and with several bristles beneath which become shorter basally. 8 rows of acrostichal hairs. Wing indices: 3.7; 1.5; 0.6 1.2).....D. vibrissina (p. 48)

16. According to Duda, sometimes very indistinct, or even absent.

SUBGENUS PHOLADORIS STURTEVANT 1942 (see p. 18)

There are two representatives of this subgenus found in England, D. deflexa (= D. guyenoti) and D. rufifrons (= D. nitens). They can be distinguished as follows:

D. deflexa

1. Mesonotum dark greyish brown, matt.
2. Ocellar triangle and orbits brown, same color as the forehead or lighter, the latter diverging anteriorly from the border of the eye.
3. Postverticals crossed
4. Forehead anteriorly wider than medially long.
5. Second orbital $1/2$ the 1st standing outside the latter.
6. Wing surfaces dirty yellow; veins brownish.
7. Claspers of the male straight and thick, with a comb of long peg-like bristles (fig. II-7).

D. rufifrons

1. Mesonotum blackish brown, shining.
2. Ocellar triangle and orbits black, darker than the forehead, the latter not diverging anteriorly from the border of the eye.
3. Postverticals convergent, not crossed
4. Forehead anteriorly as wide as or narrower than medially long.
5. Second orbital very short $< 1/2$ the 1st, standing behind, but not outside the latter.
6. Wing surface pale yellowish; veins yellow.
7. Claspers of the male long, thin and curved, with a long comb of short peg-like bristles (fig. II-8).

8. Strong costal bristles up to more than $\frac{1}{2}$ the 3rd costal segment.

9. Wing indices: 2.1; 2.1; 1.2; 1.7.

10. Palps brown.

8. Strong costal bristles up to less than $\frac{1}{2}$ the 3rd costal segment.

9. Wing indices 2.0^o; 2.6^o; 1.5^o; 2.2^o 17

10. Palps yellow.

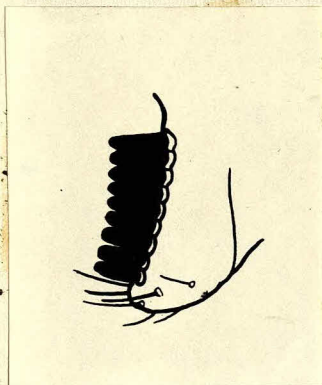


Fig. II-7. Claspers of the male of D. deflexa

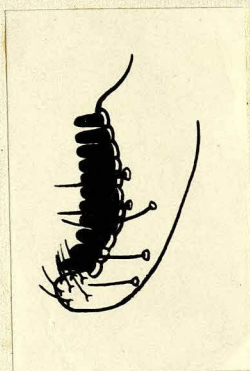


Fig. II-8. Claspers of the male of D. rufifrons

D. DEFLEXA DUDA 1924

Duda (1924: a: 222) has a key but no description.

Duda (1924: b: 304) gives an extensive description.

Duda (1935: 78) has a more complete description than the previous article. He changes nothing, but adds a description of the orbital bristles and abdominal coloration.

Burla (1948: 277-279) has a redescription of the above species, calling it D. guyenoti, and includes an illustration of

17 Only 2 specimens of D. rufifrons caught.

the head and ovipositor lamellae of the female. Although less complete than Duda's description of the external characteristics, Burla's article refers to the presence of prescutellar bristles and enlarged frontal hairs (not noticed by Duda). Burla describes the lateral margins of the forehead as being almost parallel, whereas Duda describes the forehead as becoming wider posteriorly. The English material agrees better with Burla's description, for the lateral margins of the forehead are almost parallel, though they diverge at about the level of the posterior ocelli.

Wheeler (1949: 148) excludes this species from the subgenus Pholadoris, but does not say why.

Burla's (1951: 72-74) is virtually the same as the previous description by the same author, but details of internal characteristics are added. On the basis of more extensive investigation, Burla includes this species (as D.guyenoti) in the subgenus Pholadoris and redefines the subgenus.

Herting (1953: 166-167) demonstrates the synonymy of D.guyenoti with D.deflexa.

D. RUFIFRONS LOEW 1873

Loew (1873: 50) has a very brief characterization, mentioning the reddish forehead, slightly shaded thorax, shining abdomen, short wings, short distance between the cross-veins,

and simple front tarsus of the male.

Duda (1935: 94) gives an excellent description of the external characteristics.

Buzzati-Traverso (1943: 37-44) redescribes this species as D.nitens and gives an excellent description, including figures of the male and female genitalia, the head, and the wing. Those of the male genitalia, particularly, agree extremely well with the specimens I have seen. He places the species in the subgenus Sophophora, stating that it has affinities to subgroups 1 and 3 of this subgenus.

Wheeler (1949: 147-155) places D.nitens in the subgenus Pholadoris, giving a detailed summary of how the various characteristics of this species compare with other representatives of this subgenus.

Burla (1951: 70-72) translates Buzzati's description into German, and gives figures of the head and ovipositor lamella of the female.

Herting (1953: 166-167) demonstrates the synonymy of D.nitens with D.rufifrons.

SUBGENUS DORSILOPHA STURTEVANT 1942 (see p. 19)

The only known representative of this subgenus is the distinctive cosmopolitan species, D. busckii.

D. BUSCKII COQUILLET 1901

Coquillett (1901: 18) describes and names it D. busckii. Many of the characteristics mentioned could refer to any member of the genus Drosophila, but the mesonotal and pleural pattern, and the dark brown antennae and black ocellar dot clearly refer to the species I have seen.

Sturtevant (1918: 445) in a key to the nearctic Drosophila, refers to the species as D. busckii. This name has been used by American workers on the genus Drosophila.

Sturtevant (1921: 77-78) has a description of the external characteristics, and gives a list of numerous substances from which this species has been bred. His figure, plate 2-2, shows a specimen which is duller than the ones I have caught. Fig. 18 shows the male genitalia.

Duda (1935: 77) gives a more extensive description, confirming that of Sturtevant. He describes the carina as not very nasiform and $2/3$ as long as the height of the face, but this does not seem to correspond to the specimens I have seen as closely as Sturtevant's description "Carina high, slightly flattened".

Patterson (1943: 63-65) has a description almost identical with that of Sturtevant, but adds illustrations

and descriptions of the internal characteristics, eggs and pupae (fig.12). A misprint seems likely here, for he describes the forehead as being "wider below", whereas Sturtevant says it is "wider above". The latter agrees with all the specimens of D. busckii I have seen.

Burla (1951: 75-76) gives a translation of Patterson's article, correcting the apparent misprint, and giving the sternal index. He points out that, though D. busckii is not the valid name, it is the one which is in general use.

SUBGENUS SOPHOPHORA STURTEVANT (see p. 20)

MELANOGASTER GROUP

"Yellowish species; rather long ventral receptacle; medium long spiral testes; no opaque areas on tergites; larvae do not skip; sex-combs present; sterno-index .5 to .6; anterior scutellars convergent." (Sturtevant 1943: 29).

There are two representatives of this species group on the British check list, D. melanogaster and D. simulans. They are very difficult to distinguish, and since I did not catch the latter species, the following discussion is based on the descriptions of other authors, and laboratory stocks of D. simulans. Burla (1951: 82) gives the following differences:

D. simulans

Wings relatively smaller
Cheek width (underneath the eye)
very narrow, about 1/10 or less
(the greatest eye-diameter)
(fig. II-9)



Fig. II-9. The head of D. simulans
(not showing the orbital bristles)

Palps incised inside; outside
widened like a spatula

D. melanogaster

Wings relatively longer
Cheek width about 1/6
(fig. II-10)



Fig. II-10. The head of D. melanogaster
(not showing the orbital bristles)

Palps narrower, outside a
little widened; inside
scarcely incised.

Patterson (1943: 72) also notes that the abdomen of the male of D.simulans is shorter and somewhat thicker. However, the only certain means of identification is the structure of the male genitalia.

Salles (1947) has done an intensive survey, and found numerous differences between the genitalia of the two species. The most useful distinguishing feature is the one noted by Sturtevant in his type description. The genital arch of both species has a process, but that of D.melanogaster (fig.II-11A) is much smaller than that of D.simulans (fig.II-11B), which, according to Patterson, is "shaped like a clam-shell".

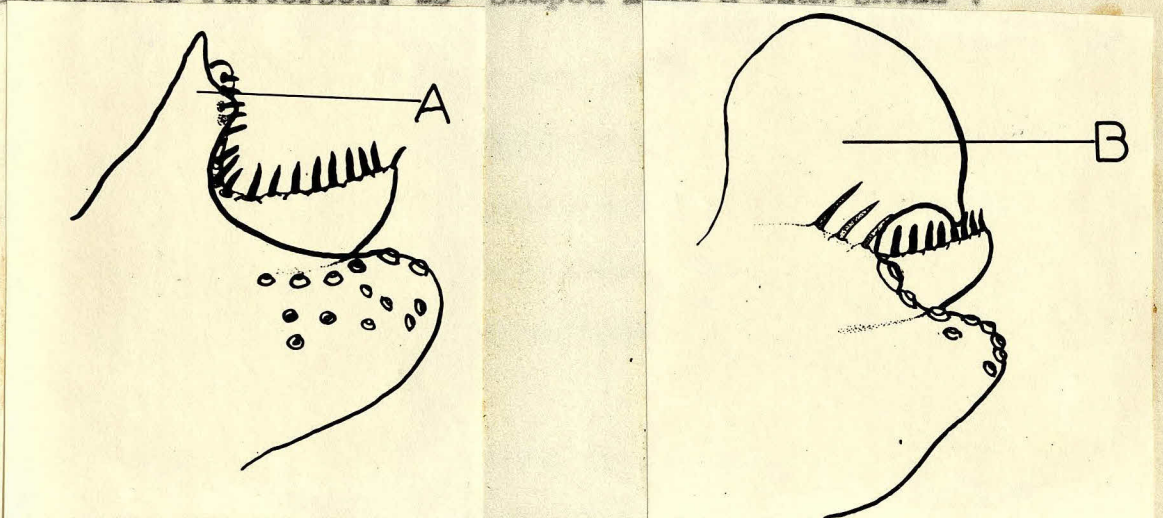


Fig.II-11. Process on the genital arch of A. D.melanogaster
B. D.simulans

D. MELANOGASTER MEIGEN 1830

Meigen (1830:85) describes D.melanogaster as a species with yellow head, legs and thorax; and black abdomen.

Sturtevant (1921: 89-91) gives an adequate description

with a color plate (3-2) of this small, cosmopolitan species which is extensively used in genetics research.

Duda (1935: 78) gives an extensive description of the external morphology of the same species, calling it D. fasciata Meigen. Duda considers D. melanogaster Meigen to be a synonym for D. fenestrarum Fallén.

Sturtevant (1939: 141) writes of the species he described as D. melanogaster "This is the species known to all geneticists under this name (synonym, D. ampelophila Loew). Some authors now use the name D. fasciata Meigen. There is some reason for this substitution; but I am not convinced that the argument is conclusive. In any case, there is no other species to which the name melanogaster is properly applicable; and with so widely known and unambiguous a name I am convinced that too close adherence to the strict rules of taxonomy is only pedantic and confusing." Subsequent workers in the field have followed Sturtevant's suggestion.

Patterson's (1943: 71-72) is based on Sturtevant's description (1921) with the addition of descriptions of the internal characteristics.

Burla (1951: 77-81) gives a translation of Patterson's description differing in no respect.

D. SIMULANS STURTEVANT 1919

Sturtevant (1919: 152-155) gives a figure of the male genitalia.

Sturtevant (1921: 91-92) gives the same figure of male genitalia, and adds a figure of the head.

Patterson (1943: 72-73) has figures of the male and female reproductive systems, egg and pupa.

Burla (1951: 81-82) shows figures of the head, palp, and genital arch.

None of the above authors give a description of D. simulans, but merely indicate the differences between this species and D. melanogaster.

OBSCURA GROUP

"Dark species; no opaque areas on tergites; larvae do not skip; sex-combs present; preapicals on first tibiae unusually long; sterno-index about .6; anterior scutellars convergent; second orals small; middle orbital large."

Subgroup (a) "Several teeth in distal sex-comb; 8 acrostichal rows; ventral receptacle short; testes elliptical; carina broad, flat."

Subgroup (b) "One tooth in distal sex-comb; 6 acrostichal rows; ventral receptacle nearly as long as in (melanogaster group); testes rather short but still spirally coiled; carina narrow, not flat."

(Sturtevant 1943: 29)

Five British species, D. subobscura, D. obscura, D. tristis, D. ambigua, and D. obscura-X¹⁸, belong to group (a) D. helvetica, according to Burla (1951: 84) belongs to subgroup (b). However, to include this species the diagnostic characteristics of the subgroup must be extended, since D. helveticus has two teeth in the distal sex-comb.

It is not possible to construct a reliable key which includes both males and females, since the most useful diagnostic characters are the shape of the genitalia. Consequently the two sexes are considered separately.

I have used mostly structural features in the keys,

18. Species still to be validly named by Basden (1952: 200).

because color, which is one of the ways of distinguishing the species, varies considerably with age and season. (There is often more difference in color between young and old individuals of the same species than between individuals of approximately the same age and different species. Burla (1951: 52-53) has a good discussion of this point.)

All characters used in the key are described and illustrated in figs. II-12 to II-38. These characters are most easily observable on live material or specimens preserved in alcohol, and a magnification up to X 60 is sometimes necessary. The figures are diagrams made after studying preserved and live material.

The range of variability is given for the two measurements used in the key (tabs. I and II). It is clear that there is overlapping and the wing indices and number of teeth in the tarsal comb are not always diagnostic characters. However, taken in conjunction with the shape of the genitalia and coloring of the thorax, they are very useful characters for distinguishing species.

In addition to the species described in this key, there are two representatives of the obscura group, D. bifasciata and D. alpina, which have not been found in Great Britain. The male genitalia of D. bifasciata Pomini (1940: 155-157) have been illustrated in a previous article (Cain et al. 1952); and D. alpina Burla (1948: 274-276) is easily recognized by the very long sex-combs of the male, and the absence of combs on the clasper.

Table II-1

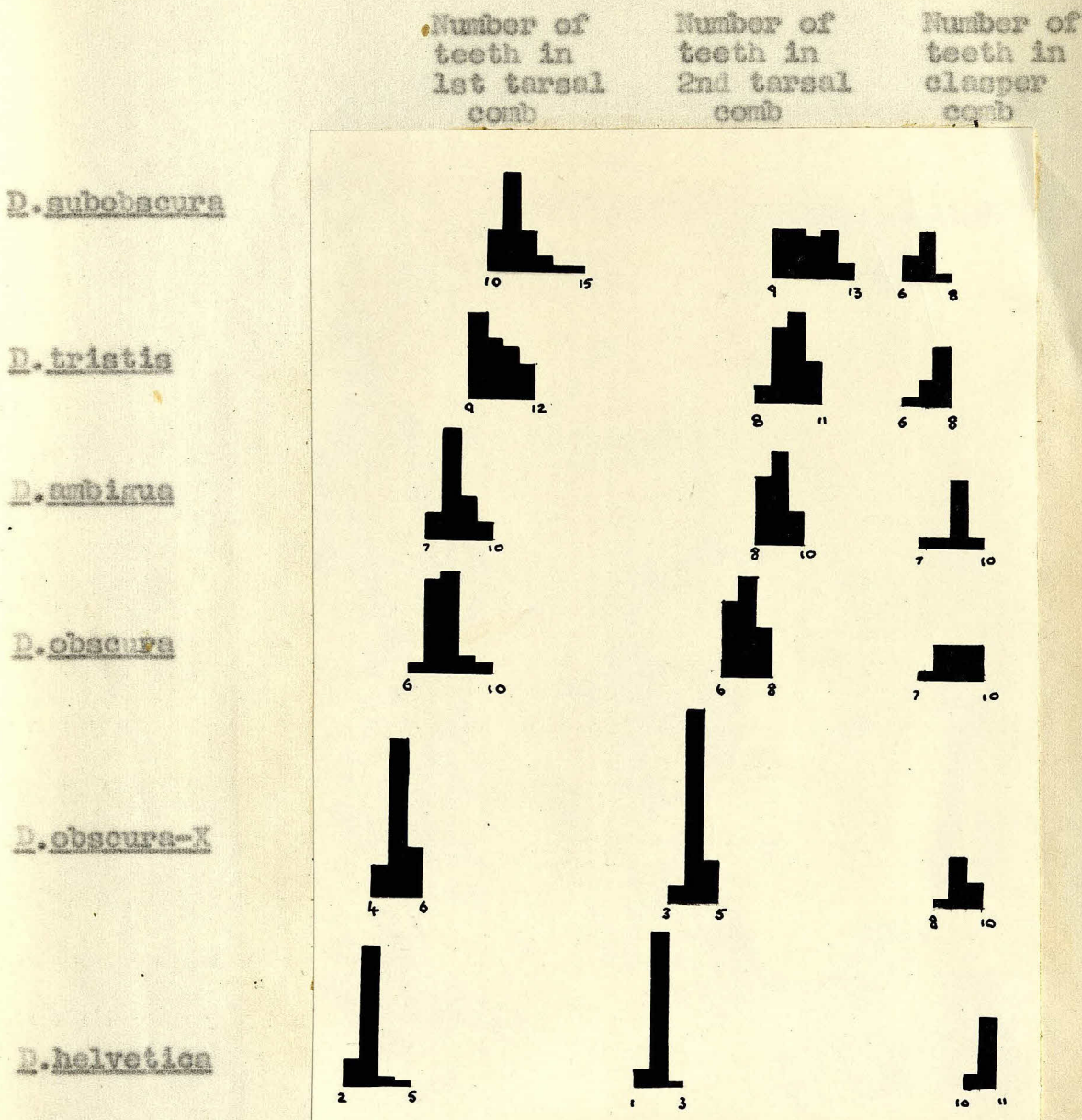


Table II-1. The variability in the number of teeth in the tarsal and clasper combs in the six species of the obscura group

Table II-2

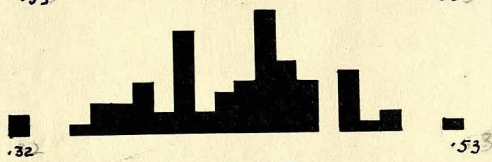
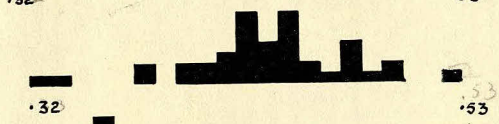
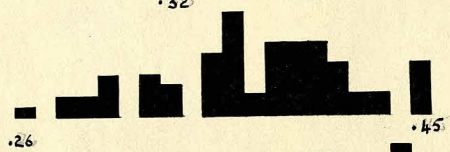
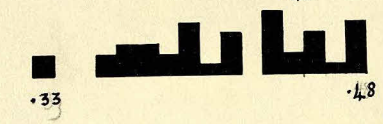
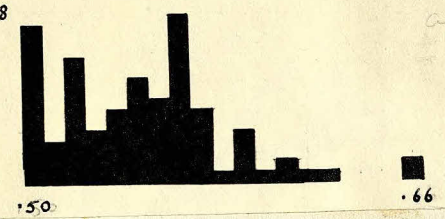
D. tristisD. obscuraD. obscura-XD. helveticaD. ambiguaD. subobscura

Table II-2. The range of variability of ratio of length of the 3rd costal segment covered by long bristles to the total length of the 3rd costal segment.

Key to the males of the obscura group

1. Tarsal combs very short, 2-5 peg-like bristles in the 1st, and 2-3 in the 2nd (tab. II-1). Clasper comb with 10-11 short bristles, those at the two ends being shorter than those in the middle, and occasionally standing apart from the main body of the comb (fig. II-12). Carina inconspicuous and receding in the lower half of the face, just below the 2nd antennal segment (fig. II-13)

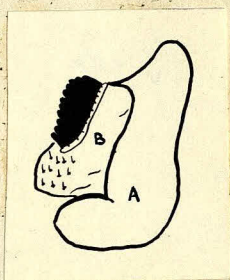


Fig. II-12. Left genital arch of D. helvetica showing A, the external process and B, the median process. Bristles on the external process not shown

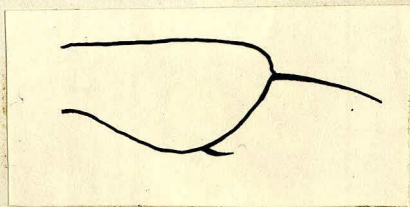


Fig. II-14. Palp of D. helvetica

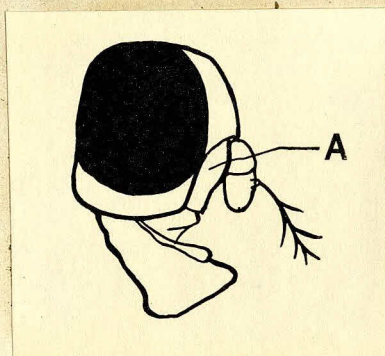


Fig. II-13. Carina of D. helvetica



Fig. II-15. Left anal plate of D. helvetica

(Palps very rotund, with one conspicuous terminal bristle (fig. II-14). Thorax dark brown, with lighter sides. The external process of the genital arch has a very characteristic angular shape, giving it a square appearance when viewed from above. Median process very large and bulky, with the clasper comb on top (fig. II-12). Anal plates as in fig. II-15. Wing indices: 2.2 - 2.8; 2.1 - 2.3; 1.0 - 1.4; 1.7 - 2.2).....D. helvetica (p. 72)

Tarsal comb longer: 4-15 bristles in the 1st and 4-12
(occasionally 3) in the 2nd.
Teeth of the clasper combs
of about equal length
Carina rather conspicuous
(fig. II-16).....2

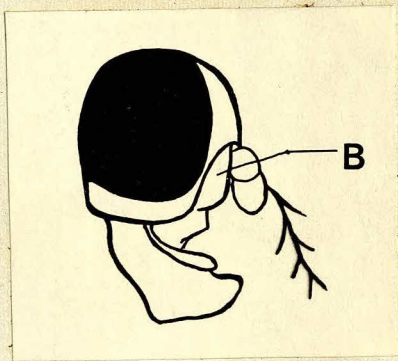


Fig. II-16. Carina as found in group (a) of the obscura group

2. Wings shaded with black on the anterior distal portion.^{19.}

Palps with two equally strong bristles, one terminal, and one subterminal (fig. II-17).^{20.} (Thorax blackish brown with

19. Rarely, D. tristis males do not have shaded wings.

20. Rarely, D. subobscura individuals occur with two long bristles close together near the end of the palp, but I have only seen this on one of the two palps.

two wide, unclear longitudinal stripes. 1st and 2nd tarsal

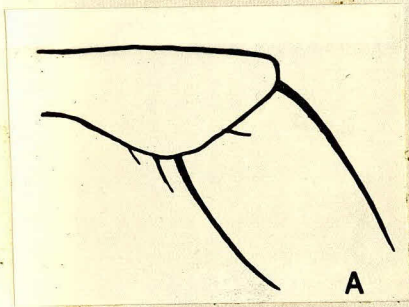


Fig. II-17. The palps of D. tristis, showing the two conspicuous bristles

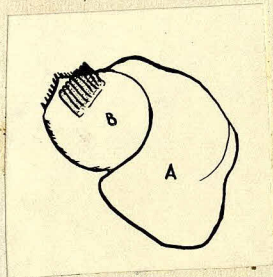


Fig. II-18. The genital arch of D. tristis showing A the external process; B, the median process. Bristles on the external process not shown

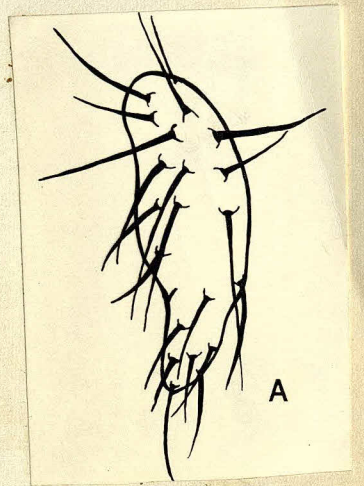


Fig. II-19. The left anal plate of D. tristis

segments with combs occupying about 1/2 of the segment, and the 1st with 9-12 peg-like bristles, the 2nd with 8-11 (tab. I). External process of the genital arch obtusely wedge-like and short. Median process very round and cup-shaped, containing within it a dense, black clasper comb of 6-8 peg-like bristles (fig. II-18) Analplates as in fig. II-19. Wing indices:

2.6; 1.8; 0.9; 1.7^a)D. tristis (p. 71)

Wings not shaded. Palps with a long terminal bristle, and sometimes a shorter subterminal one.....3

3. Clasper comb very short and square, with 6-8 peg-like bristles.
External process of the genital arch rounded and bulging at
the base, and drawn out into a thin process (fig. II-20) (This
gives the genital arch a rounded appearance.

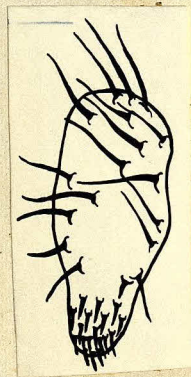
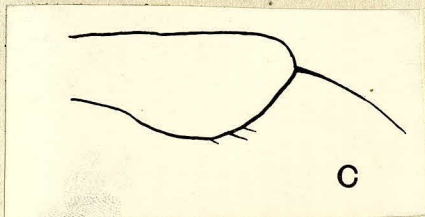
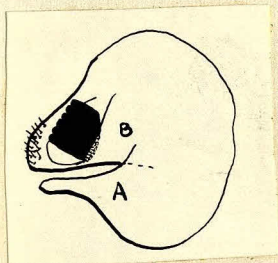


Fig. II-20. Left genital arch of D. subobscura showing A, the external process and B, the median process. Bristles on the external process not shown

Fig. II-21 Palp of D. subobscura

Fig. II-23 "left anal plate of D. subobscura

When viewed from above Palps rounded with one conspicuous terminal bristle (fig. II-21) Thorax uniform dark greyish black. Median process of the genital arch large and cup-shaped, laterally compressed, with the clasper comb contained within it (fig. II-20). Anal plates as in fig. II-22. Wing indices 2.8[♂]; 1.9; 1.0; 1.7).....D. subobscura (p. 70)

Clasper comb less compressed (7-11 bristles). External process of the genital arch wedge-shaped or subtruncate.....4

4. External process of the genital arch long and wedge-shaped, as long or only slightly shorter than the median process (fig.

II-23). (Palps elongated with one strong terminal bristle, and a shorter subterminal one (fig. II-24). Thorax yellowish brown with 2 clear darker longitudinal stripes. Tarsal combs covering $1/4 - 1/2$ of the 1st and 2nd tarsal segments, with 6-10 peg-like bristles in the 1st and 6-8 in the 2nd (tab. II-1) Median process of the genital arch long and graceful with a comb of 7-10 peg-like bristles contained within it, on a raised

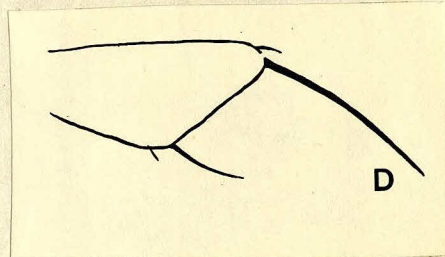
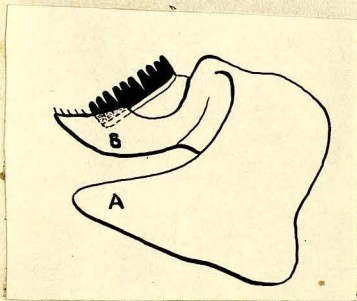


Fig. II-23. The left genital arch of D. obscura showing A the external process and B. the median process. Bristles on the external process not shown

Fig. II-24. Palp of D. obscura

Fig. II-25. The left anal plate of D. obscura

internal process (fig. II-23). Anal plates as in fig. II-25.

Wing indices: 2.9; 1.9; 0.9; 1.8°).....D. obscura (p. 64)

External process considerably shorter than the median process..... 5

5. Tarsal combs quite short, occupying $1/6$ to $1/3$ of the 1st and 2nd tarsal segments, and with 4-6 bristles in the 1st and 3-5

in the 2nd (tab. II-1). (Palps very elongated with a strong terminal and weak subterminal bristle (fig. II-26))

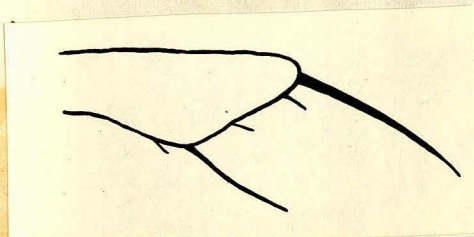


Fig. II-26. Palp of D. obscura-X

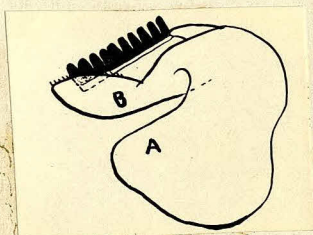


Fig. II-27. Left genital arch of D. obscura-X showing A. external process and B. median process. Bristles on the external process not shown



Fig. II-28. Left anal plate of D. obscura-X

Thorax uniform dark brown. External process of the genital arch considerably shorter than the median process. Median process very long and rather irregular, containing the long clasper comb of 8-10 peg-like bristles on a raised internal process (fig. II-27) Anal plates as in fig. II-28. Wing indices: 2.4-3.1; 2.0-2.4; 0.9-1.1; 1.6-2.0²¹).....D. obscura-X (p. 73)

Tarsal combs rather long, occupying 1/3 to 1/2 of the 1st and 2nd tarsal segments, and with 7-10 peg-like bristles in the

21. Not given by Burla

lat and 8-10 in the 2nd (tab.1). (Palps elongated with

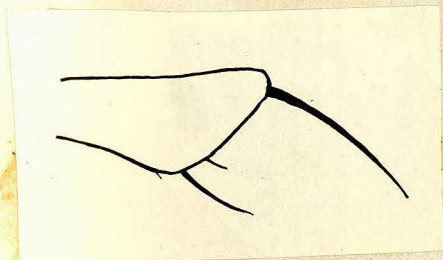


Fig. II-29. Palp of B. ambigua

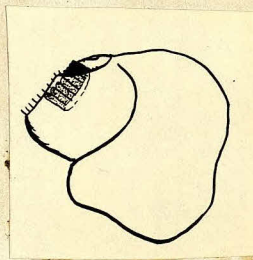


Fig. II-30. Left genital arch of B. ambigua showing A. external process and B. median process. Bristles in the external process not shown

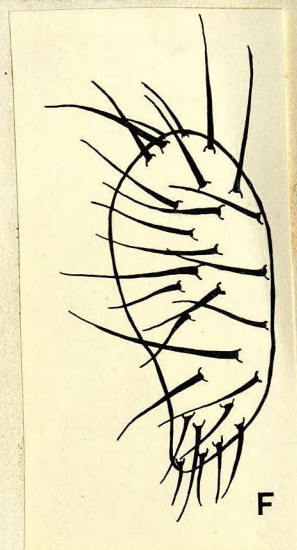


Fig. II-31. Left anal plate of B. ambigua

a strong terminal bristle, and a subterminal one, sometimes almost as long as the terminal one (fig. II-29). Thorax uniform dark greyish-brown. External process of the genital arch sub-truncate and short. Median process very rounded and cup-shaped, containing within it the clasper comb of 7-9 peg-like bristles (fig. II-30). Anal plates as in fig. II-31. Wing indices: 2.9; 1.9; 0.9; 1.3) B. ambigua (p. 72)

Key to the females of the obscura group

1. Carina inconspicuous and receding in the lower half of the face, starting just below the 2nd antennal segment (fig. II-13). Ovipositor lamellae with a distinct brown border, and without conspicuous thickened peg-like bristles (fig. II-32). Palps

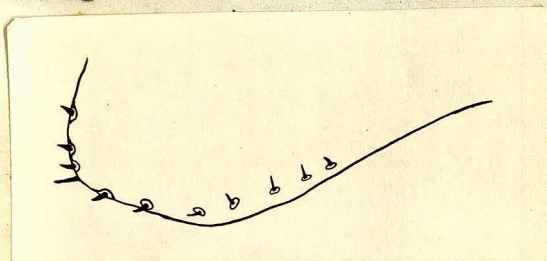


Fig. II-32. Right ovipositor lamellae of D. helvetica
1.7 - 2.2.....

very rotund, with one conspicuous bristle which is terminal (fig. II-14). Thorax dark brown with lighter pleurae. Wing indices: 2.2 - 2.8; 2.1 - 2.3; 1.0 - 1.4;

.....D. helvetica (p. 72)

Carina rather conspicuous (fig. II-16). Ovipositor lamellae pale yellow with thickened peg-like bristles.....2

2. Palps with two equally strong bristles, one terminal, one sub-terminal (fig. II-17) Ovipositor lamellae pointed, with

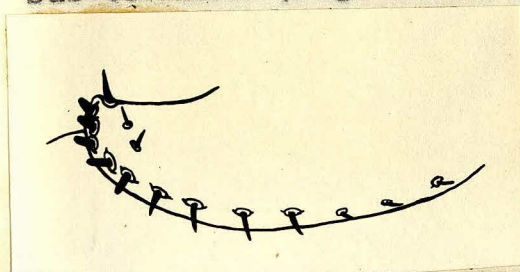


Fig. II-33. Right ovipositor lamella of D. tristis

conspicuous bristles (fig. II-33)

Thorax blackish brown, with two wide, unclear longitudinal stripes.

Wing indices: 2.6; 1.8; 0.9; 1.7*

.....D. tristis (p. 71)

Palps with only a long terminal bristle, and sometimes a shorter subterminal one.....3

3. Yellow patches on the anterior ventral border of the 5th and 6th, and sometimes the 3rd and 4th tergites²². One or two

22. These vary considerably. Sometimes the patches are clear and unmistakable; sometimes they are very inconspicuous.

long thin bristles on the ovipositor lamellae at least 4-5 times as long as the other bristles.....4

No yellow patches on the anterior ventral border of the tergites. Ovipositor lamellae with one thin longer bristle about 2-3 times as long as the other short, stout bristles.....5

4. Thorax yellowish brown with two clear darker longitudinal

stripes. Only one prominent bristle on the edge of the ovipositor lamellae (fig. II-34). Palps elongated with one strong terminal bristle, and a shorter subterminal one (fig. II-24).

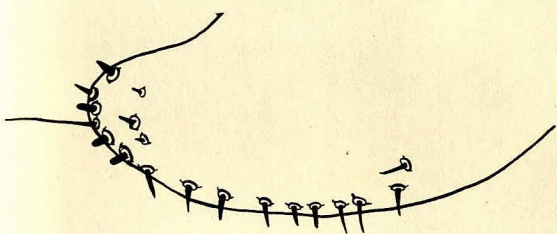


Fig. II-35. Right ovipositor lamella of D. obscura ♀

Wing indices: 2.9; 1.9; 0.9; 1.8[♂].....D. obscura (p. 64)

Thorax uniform dark brown, lighter in the region of the transverse suture, humeri and pleurae. Two prominent

bristles on the edge of the ovipositor lamellae (fig. II-36)

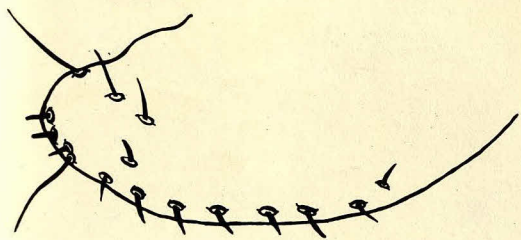


Fig. II-36. Right ovipositor lamella of D. obscura-X ♀

Yellow spots very conspicuous, expanded and sometimes visible on the 3rd tergite. Palps very elongated with a strong terminal bristle and a weak subterminal

Wing indices: 2.4 - 3.1;

2.0 - 2.4; 0.9 - 1.1; 1.6 - 2.0.....D. obscura-X (p. 73)

5. Thorax uniform dark greyish brown. Costal bristles up to at least 1/2 of the 3rd costal segment (tab. II-2.) Ovipositor

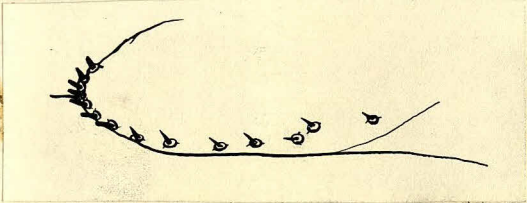


Fig. II-37. Right ovipositor lamella of D. subobscura

lamella as in fig. II-37. Palps rounded with a conspicuous terminal bristle (fig. II-21) Wing indices: 2.8⁸ ; 1.9; 1.0; 1.7.....
.....D. subobscura (p. 70)

Thorax uniform dark greyish brown. Costal bristles up to

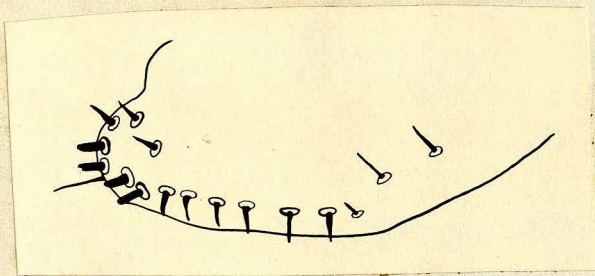


Fig. II-38. Right ovipositor lamella of D. ambigua

less than 1/2 of the 3rd costal segment (tab. II).

Ovipositor lamellae as in fig. II-38. Palps with one strong terminal bristle, and usually a shorter, weaker sub-terminal one (sometimes almost as long as the terminal

one) Wing indices: 2.9; 1.9; 0.9; 1.3....D. ambigua (p. 72)

D. OBSCURA FALLÉN 1823

Fallén (1823: 6) describes the species as having a dark head, thorax and abdomen, pale legs, and unspotted wings. This very brief description has caused confusion in the nomenclature of the obscura group.

Sturtevant (1921: 93-94) does not, in fact, describe D. obscura, since his description is of a nearctic species, and D. obscura is palearctic.

Duda (1935: 90-91) includes at least two species in his description of D. obscura, since he considers D. triatic to be merely a male variety of D. obscura. The range of color given would indicate that D. subobscura was also included in Duda's description.

Pomini (1940: 149-152) redescribes D. obscura as D. obscuroides. He gives detailed descriptions of color, markings and pubescence; but in fact these vary so much with age, that the descriptions are of little use. He gives an illustration of the male genitalia, which do not show adequately the characteristics which are, in fact, the most certain means of species identification.

Buzzati-Traverso (1949: 88, personal communication in Drosophila Information Service) states that the type description of D. obscura is so vague as to be applicable to at least five European species. He suggests that since the most common species collected by Professor K. Anders at Esperöd, Sweden (the type locality of D. obscura) was D. subobscura (though D. obscuroides

was also found there), the former species should be considered to be D. obscura Fallén. This was an unfortunate suggestion, running counter to the agreed taxonomic procedure, since the type specimen is in existence. Lever and Strobl (1951: 2) wrongly refer to "Drosophila obscura Fall., syn. subobscura (Collin 1936)", apparently following Buzzati-Traverso's suggestion.

Burla (1951: 89-91) gives an excellent description (calling the species D. obscuroides Pomini) with illustrations of the differences between the various species of the group (figs. 15-20).

Cain, Collin and Demerec (1952: 193-196) examined the type of D. obscura Fallén, and were able to determine that D. obscuroides Pomini is a synonym of D. obscura Fallén (pp. 66-69)

CORRECT APPLICATION OF THE NAME *DROSOPHILA OBSCURA* FALLÉN
AND NOTES ON THE TYPE OF *D. TRISTIS* FALLÉN
(DIPT., DROSOPHILIDAE)

BY A. J. CAIN, J. E. COLLIN AND V. R. DEMEREC

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Pomini (1940) has shown that besides *Drosophila subobscura* Collin (1936: 60) and *D. tristis* Fallén (1823: 7) there are at least three other dark species of the *obscura*-group of *Drosophila* in Europe: Burla (1948) has added two others from Switzerland. However, the correct application of the name *D. obscura* Fallén (1823: 6) has not previously been determined. Through the kindness of Dr. R. Malaise of the Riksmuseum, Stockholm, we have been able to re-examine Fallén's type, labelled *D. obscura* in his own handwriting. This is a male, now covered with mould and in very poor condition. Examination of the genitalia was found to be essential, and to facilitate this the abdomen was removed, treated with potash, cleared in clove oil and mounted whole with the ventral side uppermost.

A comparison has been made with material of the following species, similarly treated.

D. helvetica Burla, 1948, Italy. *D. tristis* Fallén, 1823, Italy, Switzerland, England. *D. ambigua* Pomini, 1940, Italy, Switzerland, England. *D. subobscura* Collin, 1936, Italy, Switzerland, England. *D. bifasciata* Pomini, 1940, Italy, Switzerland. *D. obscuroides* Pomini, 1940, Italy, Switzerland, England, Scotland. *D. sp. n. nr. obscuroides* (to be described by Mr. E. B. Basden).

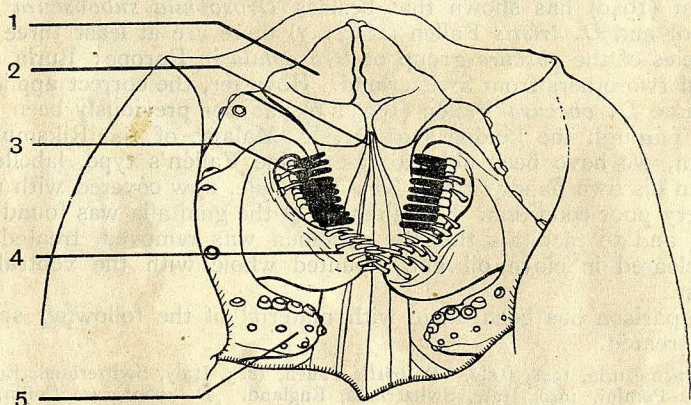
The provenance of the material examined was as follows: Italian material, from stocks of the Università Istituto di Genetica, Pavia; Swiss material, from stock of the Zoologisches Institut der Universität, Zürich; English material, collected in the wild near Oxford; Scottish material, bred from stocks of Mr. E. B. Basden, Institute of Animal Genetics, Edinburgh.

The figures illustrating this paper are camera lucida drawings of mounted abdomens; the slides, with the exception of the abdomen of the type of *obscura* (which belongs to the Riksmuseum, Stockholm) are deposited in the Hope Department, Oxford University Museum.

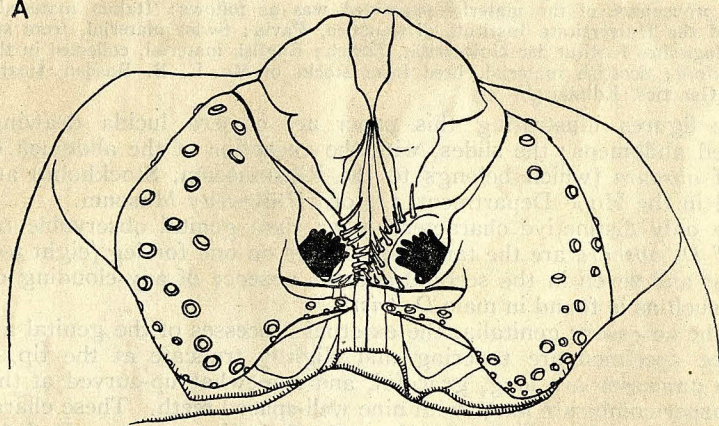
The only distinctive characters other than genital observable on the type of *D. obscura* are the tarsal sex combs on one foreleg (eight teeth in the first and seven in the second) and the absence of any clouding on the wings such as is found in male *D. tristis*.

In the accessory genitalia, the external processes of the genital arch of the type specimen are tapering and slightly truncate at the tip. The median processes are long, graceful, and somewhat up-curved at the tip. The clasper combs are long, with nine well-spaced teeth. These characters provide an immediate distinction from the following species. *D. helvetica* Burla (1948: 276-277) has very broadly rounded and partly recurved external processes, short, stubby median processes, and combs with teeth arranged rather irregularly, not in a uniform row. *D. tristis* has broad, flat external processes, long, straight median processes, and combs with teeth arranged along a shallow curve, not in a straight line. *D. ambigua* Pomini (1940: 157-159) is very similar to *D. tristis*, but with a straighter comb. *D. bifasciata* Pomini (1940: 155-157) has elongated and rounded, rather club-shaped external processes, median processes rather shorter and broader than in the type of *obscura*, but longer than in *D. helvetica*, and a straight, regular comb (fig. 1A). *D. subobscura* has most distinctive external processes, each drawn out apically into a long flattened point, median processes very large and broad, and a short, regular comb (fig. 1B). *D. obscuroides* Pomini (1940: 149-152) agrees in every way with the type of *obscura*. It has elongated external processes as in *D. bifasciata*, but wedge-shaped, not club-shaped (fig. 2A). The median processes are longer and more slender than in any of the species just discussed, and the internal processes bear a long straight comb. It has also been noted

(J.E.C.) that the male genitalia of *D. obscuroides* are distinctive in having a more ample and protuberent genital sternite than usual and longer appendages to the penis, the ventral pair of which are somewhat laterally dilated and flattened towards the tip.



A



B

FIG. 1.—Ventral view of the posterior end of the abdomen of: A, *Drosophila bifasciata* Pomini; B, *D. subobscura* Collin. Setal bases are shown only on the genital processes and nearby portions of the 9th tergite. 1, anal plate; 2, ends of penial processes; 3, clasper comb; 4, median process; 5, external process.

There is no doubt that the claspers of *D. obscuroides* are identical with those of the type specimen of *obscura* (fig. 2B) and the few other characters available support this identification. Consequently *D. obscura* Fallén, 1823, is the correct name for *D. obscuroides* Pomini, 1940 (**syn. n.**). The genitalia of *D. obscura* are exceedingly similar to those of Mr. Basden's new form, which, however, can readily be distinguished in other characters. *D. bifasciata* appears to be the next nearest as regards the form of the genitalia, but the club-shaped external processes and comparatively short median processes make separation easy. The only European species of the *obscura* group which was not examined was *D. alpina* Burla (1948: 274-276) which is readily recognised by its very long sex combs as well as the lack of clasper combs.

1952.]

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It should be noted that, as noticed by one of us (J.E.C.) the 'Fallén Collection' at Stockholm does not contain *all* the specimens from which Fallén described his species. It was presented to the Riksmuseum, Stockholm, by Zetterstedt in 1831, a year after Fallén's death, as shown by a

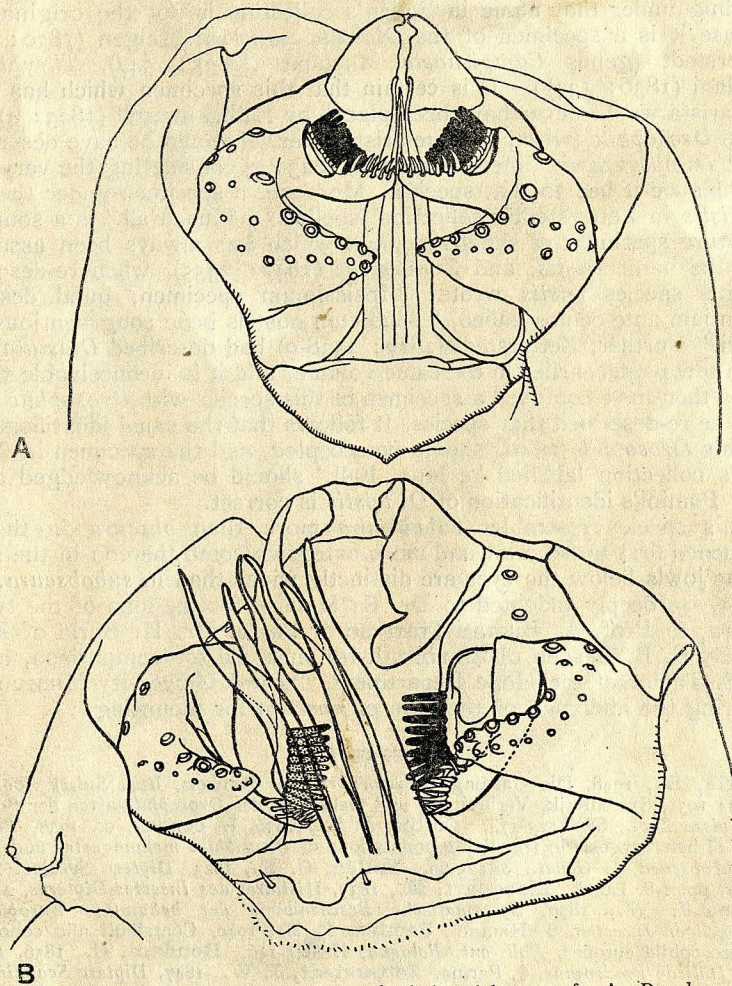


FIG. 2.—Ventral view of the posterior end of the abdomen of: A, *D. obscuroides* Pomini; B, type specimen of *D. obscura* Fallén. In B the parts are somewhat disarranged. The penial processes cover the right clasper comb. Both median processes are deflected under the external processes.

[NOTE.—The figures have been drawn by A.J.C. and V.R.D. from individual mounts and in comparing them with other similar mounts of the same species allowance must be made for any differences in the position of the various parts, such, for instance, as those of fig. 2B compared with fig. 2A.]

note in the first drawer of the cabinet which now contains the specimens. These specimens are those transferred from Fallén's collection by Zetterstedt, *who retained in his own collection other specimens of the same species*. It will be found that Zetterstedt drew special attention to such specimens (as in the case of *D. tristis* (Zetterstedt, 1847: 2555)) when he published re-descriptions of Fallén's species. Thus it is always necessary to consult Zetterstedt's work before arriving at any conclusion on the correct application of any name given by Fallén to a species and even before

selection of a lectotype, because it may be necessary for this purpose to select one of the syntypic series retained by Zetterstedt, as for instance in the case of *D. tristis*.

With regard to the latter, it appears certain (J.E.C.) that the specimen standing under that name in Fallén's collection is not the original type, because it is a specimen of the *Diastata punctum* Meigen (1830: 98) of Zetterstedt (genus *Campichoeta* Macquart (1835: 547), *Thryptocheta* Rondani (1836: 134)). It is certain that this specimen which has pubescent arista would never have been placed by Fallén himself (1823: 4) in his genus *Drosophila* (with pectinate arista), neither would he have described it as '*A. D. obscura* vix differre videtur' (1823: 7) considering the very slight resemblance it has to that species. Moreover a specimen under the name *D. tristis* in Zetterstedt's collection labelled 'e Mus. Fall.' is a somewhat immature specimen of the *Drosophila* which has always been associated with the name *tristis*, and Zetterstedt (1847: 2555), when re-describing Fallén's species *tristis* wrote: 'Ipsissimum specimen, quod descripsit Fallén jam ante oculos habeo, & illud cum nostris bene congruentibus comparavi.' Further, Zetterstedt (1847: 2538-9) had described *Diastata punctum* a few pages earlier in the same volume, and it is inconceivable that he should then have confused a specimen of this species with *Drosophila tristis* when he re-described that species. It follows that the usual identification of Fallén's *Drosophila tristis* should be accepted, and the specimen in Zetterstedt's collection labelled 'e Mus. Fall.' should be acknowledged as the type. Pomini's identification of *D. tristis* is correct.

This species resembles *subobscura* more than *obscura* in the less lengthened first tarsal joint and more extensive comb thereon in the male: but the jowls below the eyes are distinctly wider than in *subobscura*.

We are deeply indebted to Dr. R. Malaise for the loan of the type of *obscura*, to Prof. A. Buzzati-Traverso of Pavia, Dr. H. Burla of Zürich and Mr. E. B. Basden of Edinburgh for material for comparison, and to Mr. E. Taylor of the Hope Department, Oxford University Museum, for preparing the abdomen of the type of *obscura* for mounting.

REFERENCES

- Burla, H., 1948, Die Gattung *Drosophila* in der Schweiz, *Rev. Suisse Zool.*, 55: 272-279; 1951, Systematik, Verbreitung und Oekologie der *Drosophila*-arten der Schweiz, *Rev. Suisse Zool.*, 58(2): 23-174. Collin, J. E., 1936, In GORDON, C., 1936, The frequency of heterozygosis in free-living populations of *Drosophila melanogaster* and *Drosophila subobscura*, *J. Genet.*, 33: 25-60. Fallén, C. F., 1823, *Diptera Sveciae*, 2 Geomyzides, pp. 1-8, Lund. Macquart, M., 1835, *Histoires des Insectes-Diptères*, 2 Paris. Meigen, J. W., 1830, *Systematische Beschreibung der bekannten Europäischen Zweiflügeligen Insecten*, 6, Hamm. Pomini, P. F., 1940, Contributi alla conoscenza delle *Drosophila* europee, *Boll. ent. Bologna*, 12: 145-146. Rondani, C., 1856, *Dipterologiae Italicae Prodrum*, 1, Parma. Zetterstedt, J. W., 1847, *Diptera Scandinaviae*, 6, Lund.

A. J. Cain, University Museum, Oxford.

J. E. Collin, Raylands, Newmarket.

V. R. Demerec, University Museum, Oxford.

May 19th, 1952.

D. SUBOBSCURA COLLIN 1936

Collin (1936: 60) gives a brief characterization, mentioning the longer tarsal combs and lack of thoracic striping of D. subobscura, in contrast with D. obscura.

Smart (1945: 53-56) clears up the confusion in nomenclature caused by Collin's delay in naming D. subobscura. This article includes a very careful and detailed description of the species.

Ponini (1940: 160-163) gives a detailed description of color, markings and pubescence, with illustrations of the male genitalia. This is not very useful for identification of an unknown specimen.

Burla (1951: 95-96) gives an excellent description with illustrations of the differences between the various species of the group (figs. 15-22).

D. TRISTIS FALLEN 1823

Fallén (1823: 7) says this species hardly differs from D. obscura, except that the costa of the wings are blackened. This is characteristic of the males of the species now known as D. tristis: though Fallén refers to the costal blackening in the females.

Duda (1935: 90-91) includes the species as a male variety of D. obscura Fallén.

Pomini (1940: 153-155) gives a detailed, but not very useful, description. His figures of the male genitalia show structural characteristics better than his illustrations of the other members of the obscura group.

Burla (1951: 91-92) gives a careful description with illustrations of the differences between the various species of the obscura group (fig. 15-21).

D. AMBIGUA POMINI 1940

Pomini (1940: 157-159) gives a detailed description of color, markings, and pubescence, none of which are very useful for the certain identification of this species, although his illustrations of the male genitalia do assist identification.

Burla (1951: 94) gives a careful description with illustrations of the differences between the various species of the obscura group (figs. 15-20)

D. HELVETICA BURLA 1948

Burla (1948: 276-277) describes the species, with illustrations of the head, front tarsus of the male and ovipositor lamella of the female.

Burla (1951: 98-99) supplements the type description with description of the internal characteristics, and a discussion of the relationship of this species to the other members of the obscura group (p. 84).

D. OBSCURA-X

Burla (1951: 89) briefly characterizes this species, but does not validly name it.

Basden (1952: 200) mentions finding this species, and says he will name it as soon as crossing tests are completed.

Although Basden (personal communication) intends to publish a description of the species soon, there is at present no description of this species. For this reason, I am giving below a description based on the form followed by Dr Burla in his excellent descriptions of the other members of the obscura group.

Arista with 7-8 rays, usually 7. 2nd antennal segment yellowish-brown; 3rd darker. Forehead matt dark brown; orbits wide, light brown; ocellar triangle lighter than forehead. Second orbital (anterior reclinate) very close to the 1st (proclinate), sometimes anterior to it, and $1/3$ to more than $1/2$ as long as the 1st (which is usually shorter than the 3rd (posterior reclinate)). Second oral bristle $1/4$ - $2/5$ as long as the 1st and very much weaker. Face yellowish-brown. Palps grey, proboscis pale yellowish grey. Carina dark brown, wide, shaped as in fig. II-16. Palps long and narrow, with a long straight terminal bristle, and usually a weaker sub-terminal one (fig. II-26). Cheeks yellowish grey, their greatest width $1/5$ - $2/5$ the greatest

eye-diameter. Eyes very rotund and dark red.

Mesonotum matt; black with a uniform bronze-grey heariness. Scutellum more shining than mesonotum with a wide unclear lighter margin. Pleurae blacker, more shining. Legs dark yellow, becoming paler distally. 8 rows of acrostichal hairs. Anterior scutellars parallel to convergent. Sternal index about 0.5. Apical bristle on the tibiae of the 1st and 2nd pairs of legs; preapicals on all three pairs of legs. On the 1st and 2nd tarsal segments of the forelegs are sex-combs with 4-6 (usually 5) peg-like bristles in the 1st (proximal) comb, and 3-5 (usually 4) in the 2nd (distal) comb (tab. II-1). Wing surfaces colorless, veins yellowish. Two bristles anterior to the distal break in the costal vein. Strong costal bristles up to less than 1/2 of the 3rd costal segment (tab. II-2). Costal index 2.4-3.1; 4th vein index 2.0-2.4; 4c index 0.9-1.1; 5x index 1.6-2.0

Abdominal tergites shining dark brown. On the claspers are a series of 8-10 peg-like bristles (fig. II-27; tab. II-1). Anal plates as in text-fig. II-28.

Body length	2.7 ^{♂♂} -3.2	2.1 ^{♀♀} -2.8
Wing length	2.7-3.6	2.1-2.9

Female

On the sides of the 4th-6th tergites on the anterior margin are large yellowish patches, more conspicuous than

* 8 females and 25 males were measured

D. obscura. Ovipositor lamellae with 2 long subterminal bristles, one dorsal and one ventral (fig. II-36).

This species occurs with a low frequency (less than 1%) in many woodland habitats, but appears to be more frequent in the early spring.

SUBGENUS DROSOPHILA (See p. 21)

This is the largest and most complex of the subgenera of the genus Drosophila, and at least 12 of the British species are included in it.

QUINARIA GROUP

"Yellow species, shining; eggs with 3 filaments; cross-veins clouded; abdominal dark bands often broken into spots; arista with 9-11 branches." (Sturtevant 1942: 30)

The four European members of this species group are extremely variable in color, and in the patterning of the abdomen. Though they are usually yellowish brown with no distinct mesonotal pattern, or at most very indistinct longitudinal striping. I have found occasional individuals of two of the species of the group (D. kuntzei and D. liabata) with mesonota which are dark blackish brown. Although the abdominal patterning is usually as shown in the following section (fig. II-39 to fig. II-47), it is extremely variable, and cannot be used with certainty for distinguishing the four species one from another, particularly D. phalerata and D. kuntzei. The majority of the latter species caught in one locality in Sussex had an abdominal pattern resembling more closely that of D. repleta (fig. II-4) than that of typical D. kuntzei (fig. II-39). The ratio of the 1st and 2nd oral bristle, and the number of rows of acrostichal hairs, is not always as constant as Buria's key would indicate. The only completely reliable way of distinguishing between the species is by examination of the male and

female genitalia. The thoracic and abdominal colouring, the ratio of 2nd to 1st oral bristles, and the number of rows of acrostichal hairs are useful, however, in the majority of cases.

KEY

1. 8 rows of acrostichal hairs. (♀ 3.6-3.9 mm. ♂ 3.0-3.9 mm. 2nd oral bristle $1/2 - 3/4$ the 1st. Abdominal tergites with

black bands on the posterior margin which are medially interrupted, and anteriorly straightly bordered (fig II-39) Male claspers shown in fig.

II-40. Females without a dark reddish brown projection between the anal papillae and the ovipositor lamellae (which is found in D. phalerata) Ovipositor lamellae reddish brown heavily shaded

with black. Wing indices 3.6;1.7;0.7;1.1)....D. kuntzei (p. 80)

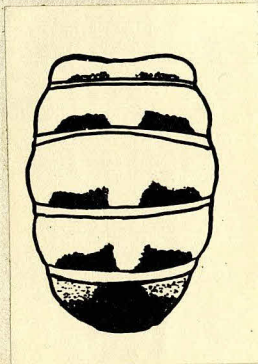


Fig. II-39. Abdomen of D. kuntzei male. Female has yellow, not black, posterior segments

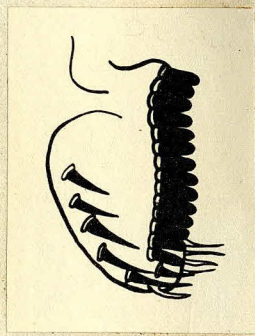


Fig. II-40. Right clasper of male of D. kuntzei

6 rows of acrostichal hairs.....2

2. Bands on the posterior margin of the tergites broken into four irregular spots, the lateral ones only rarely joined together (fig. II-41) (♀ 2.6 - 3.4 mm; ♂ 2.5- 2.9 mm. 2nd. oral

bristle 1/2 - 3/4 the 1st. Male clasper shown in fig.II-42. Female without dark reddish brown projection between the anal papillae and the ovipositor lamellae. Ovipositor lamellae reddish brown. Wing indices

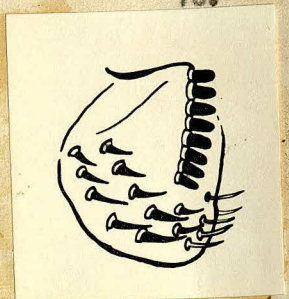
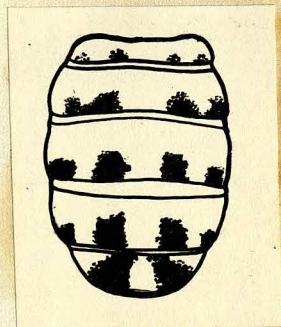


Fig.II-41. Abdomen of D. transversa male. Female very similar

Fig.II-42. Right clasper of D. transversa male

3.5; 1.8; 1.1; 0.9.....D. transversa (p. 81)

Bands on the posterior margin of the tergites medially interrupted but not broken into spots or only rarely so on one or two tergites.....3

3. Bands on the posterior margin of the tergites rather pale, very widely medially interrupted (fig.II-43) (♀ 3.6 - 3.9 mm. ♂ 3.2 - 3.6 mm. 2nd oral bristle 1/2 - 4/5 the 1st. Male clasper shown in fig.II-44 Females without a dark reddish brown projection between the anal papillae and the ovipositor lamellae. Ovipositor lamellae

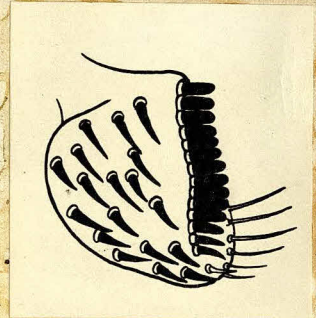
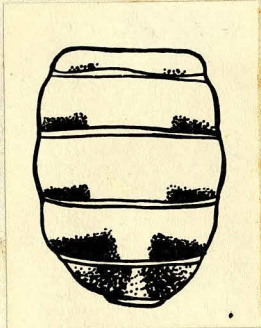


Fig.II-43. Abdomen of male D. limbata. Female very similar

Fig.II-44. Right clasper of male D. limbata

reddish brown. Wing indices 3.5* ; 1.6; 0.8; 1.1....D. limbata (p. 83)

Bands on the posterior margin dark, narrowly interrupted.

and very irregularly bordered anteriorly, occasionally broken into spots on one or two tergites (fig.II-45) (♀ 3.5 - 3.9 mm; ♂ 2.9 - 3.5 mm. Second oral bristle 1/3 to 1/2 the 1st. Male claspers shown in fig.II-46. Female with dark reddish brown projection between the anal papillae and the ovipositor lamellae (fig.II-47). Ovipositor lamellae reddish brown heavily shaded with black.

Wing indices 3.0-4.0;
1.6; 0.7; 1.0 - 1.3).....

.....

.....

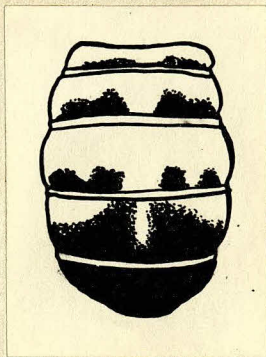


Fig. II-45. Abdomen of male D. phalerata. Female posterior segments not black

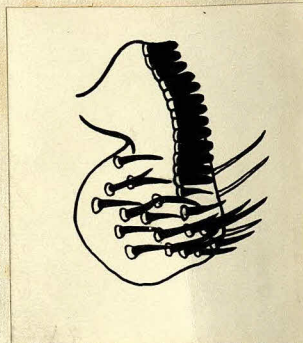


Fig. II-46. Right clasper of male D. phalerata

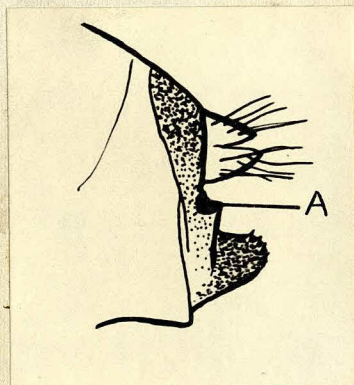


Fig. II-47. Left ovipositor lamella of D. phalerata female
D. phalerata (p. 84)

D. KUNTZEI DUDA 1924

Duda (1924: 218) gives a key to the European species, including "D. Kuntzei n. sp." No description is given, however. In the key, Duda differentiates this species from D. phalerata on the basis of the ratio of the 2nd to the 1st oral bristle, a character which I found quite variable in both species. Generally, in D. kuntzei, the ratio is greater than 1/2, whereas in D. phalerata it is less, but there is considerable overlap, and it is not always possible to determine this characteristic with sufficient accuracy.

Duda (1924 b: 288-290) has a detailed description. The figure and description of the male genitalia are of very little use, since they do not illustrate the shape of the clasper. The bristles on the palps of the English specimens also appear to be much more variable than Duda indicates.

Duda (1935: 86) gives almost the same description as above.

Burla (1951: 104-105) gives a description based on that of Duda, but including characteristics of the internal organs, eggs and pupae.

D. TRANSVERSA FALLÉN 1823

Fallén (1823: 6) describes the species as being testaceous, with blackened cross-veins, and an abdomen which is black-spotted in a double row, or has black on the segments which is apically interrupted.

Sturtevant (1921: 81) gives a more detailed description of the North American variety of this species. He calls the carina a "broad, flat", but this does not agree with the European specimens I have seen.

Duda (1924 a: 218) gives a key, but no description.

Duda (1924 b: 291-293) gives a detailed description since (as he states) Fallén's description has led to uncertainty, and often incorrect identification. He describes the carina as nasiform and deep-reaching, and the English specimens I have seen agree with this description. His description of the bristles on the palps does not correspond with many of the English specimens, however, and this character appears to be more variable than he realised.

Duda (1935: 97) extends the above description slightly.

Patterson (1943: 83) extends Sturtevant's description somewhat, and adds descriptions of the internal characteristics, eggs, and pupae.

Hsu (1949: 101) states that there are considerable differences between the genitalia of the European and North American representatives of D. transversa, and that they may, in fact, represent different species.

Burla (1951: 101-102) modifies Patterson's description slightly, but still describes the carina as broad and flat.

Okudo (1953: personal communication) has found three types of the Japanese "D. transversa", all of which differ from the European and American forms.

D. LIMBATA VON ROSER 1840

von Roser's type description was not obtainable by me.

Duda (1924 a: 218) gives a key, but no description.

Duda (1924 b: 252-253, 293-294) gives an extensive description of the external characteristics of this species. The key is almost the same as above, but his description of the bristles on the palps does not indicate the extreme variability of this character.

Duda (1935: 86-87) extends the above description slightly, including a description of the orbital bristles.

Burla (1951: 105-107) modifies and abridges Duda's description, and gives illustrations of the male genitalia and abdominal markings. He also adds descriptions of the internal characteristics, eggs and pupae.

D. PHALERATA MEIGEN 1830

Meigen (1830: 83) describes this species as having a brick-red head and thorax; reddish yellow abdomen with black interrupted bands, and brown transverse wing veins. This description might equally well apply to D.kuntzei (see below).

Duda (1924 a: 217-218) gives a key, but no description. He differentiates this species from the other closely related species on the basis of the ratio of the 2nd to the 1st oral bristle, a character which is very variable.

Duda (1924 b: 294-297) gives an extensive description, with an illustration of the posterior end of the male abdomen, which is not very useful, since it does not show the claspers. His description of the bristles on the palps does not agree with many of the English specimens of this species, and this character seems to be extremely variable. He mentions that he could not find any specimen which was for certain designated as D.phalerata by Meigen himself. However, he applies the name to the more common of the two species to which Meigen's type description might apply.

Duda (1935: 92-93) extends his previous description slightly, adding an account of the orbital bristles.

Burla (1951: 102-104) gives, more or less, a condensation of Duda's account, with illustrations of the abdominal pattern, and the male and female genitalia. He also describes the internal characteristics, and eggs and pupae.

VIRILIS GROUP

"Blackish species; anterior scutellars divergent; posterior cross-veins clouded; sterno-index .8 to .9." (Sturtevant 1942: 30)

There is only one representative of this species group found in Great Britain.

D. LITTORALIS MEIGEN 1830

Meigen (1830: 87) describes the species as having a reddish yellow head and thorax; black abdomen; black anterior legs, and reddish yellow posterior legs; white halteres; and clear wings.

Duda (1935: 87-88) gives an excellent description of the external characteristics.

Burla (1951: 107-109) has more-or-less a condensation of Duda's account, with, in addition, descriptions of the internal characteristics, eggs, and pupae. His figure of the female ovipositor lamellae does not, however, show the conspicuous darker basal bristles, which I have seen in English specimens.

Patterson (1952: 7-19) redescribes D. littoralis and discusses its relationships to other members of the virilis group

Duda (1935: 98-99) and Burla (1951: 109-111) describe a rather similar species, D. unimaculata, which also occurs in woodlands near streams. This species has not been reported from England, but can be identified by its larger size (according to Burla, about 4.5 mm. instead of about 3.6 mm), and lighter thorax.

REPLETA GROUP

"Grayish mesonotum, each hair and bristle arising from a black or dark brown spot; 8 to 9 branches of the arista; "horn" of puparium usually more than $1/4$ length of puparium; costal index from 2.5 to 3.5". (Sturtevant 1942:31) "testes usually tightly coiled, and the ventral receptacle in many forms tightly coiled like the spring of a screen door" (Patterson and Stone 1952: 30).

There are 49 species described to date, two of which (D. repleta and D. hydei) have been reported from Northern Europe.

Burla (1951: 114-115) gives the following characteristics to distinguish D. repleta from D. hydei:

<u>D. repleta</u>	<u>D. hydei</u>
Cheeks narrow ($1/4$)	wide ($1/3$)
1st costal segment apically black	light
Wing veins brown	yellowish
Wing surfaces yellowish	colorless
Costal index 3.0 ^{23.}	3.4
No long, backward bent hairs on the fore tarsus of the males	present
Anterior coxa dark	light
Abdominal tergite with clear yellow lateral spots	usually without

23. Given by Sturtevant (1921:100) as 3.4

Large animal, yellowish brown
ground color

Large, yellowish brown

In my collections, I did not find any specimens of D. replata and was not, therefore, able to compare living specimens of the two species. A comparison of Italian stocks, preserved in alcohol, showed that there were difficulties in making positive identifications when using the characters listed by Burla. When the characters are as close as $1/3$ and $1/4$ of the eye-diameter, the distinction between 'wide' and 'narrow' cheeks is sometimes difficult to judge. (some of the English specimens of D. hydei I caught has a cheek/eye-diameter ratio of $7/25$). When specimens of the two species are compared, the apical darkening of the 1st costal vein of D. replata is quite clear, as is the difference in the wing membrane and wing vein coloring. Although they are obvious when comparing individuals of the two species, these features are much less apparent when one attempts the identification of a particular specimen.

The specimens of D. replata from Italy, as well as those of D. hydei from Italy and England, showed the backward-bent hairs on the fore tarsus of the males. Since the anterior coxa of the specimens of D. hydei sometimes have a grayish-black wash, the darker anterior coxa is not invariably characteristic of D. replata. Almost all specimens of D. hydei showed a clear yellow lateral spots on the anterior tergites, and sometimes (though not very clearly) on the 5th and 6th tergites also. The

differences listed by Burla make it possible to identify most specimens, but quite a few doubtful cases remain.

In addition to the characters listed above, I find that the genital arch of the male, and the ovipositor lamellae of the female, clearly differ between the two species. With live material, or with material preserved in alcohol, this is one of the most certain means of identification.

The genital arch of the male of D. hydei (fig. II-48)

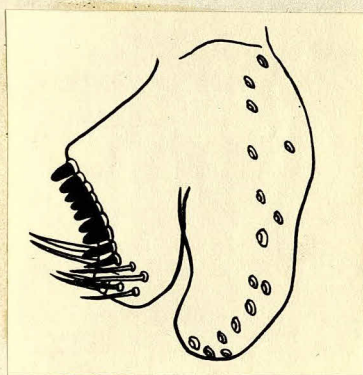


Fig. II-48. Left genital arch of D. hydei

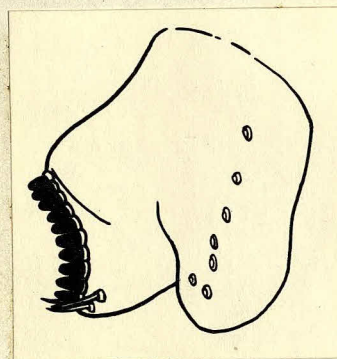


Fig. II-49. Left genital arch of D. repleta

has a comb which does not reach to the apex of the clasper, which has long black apical bristles. The comb of D. repleta reaches the end of the clasper (fig. II-49), which has no long black apical bristles.

The ovipositor lamellae of D. hydei (fig. II-50) are apically rounded, and the dorsal and ventral sides are almost parallel; the bristles of the lamellae are yellowish and quite distinct at a magnification of x 60. The ovipositor lamellae of D. repleta are more pointed apically (fig. II-51), with the dorsal

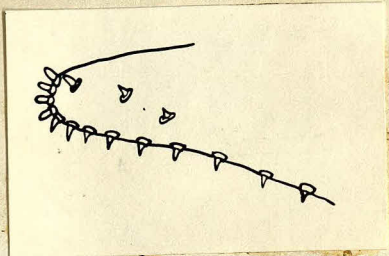


Fig.II-50. The right ovipositor lamella of D.hydei

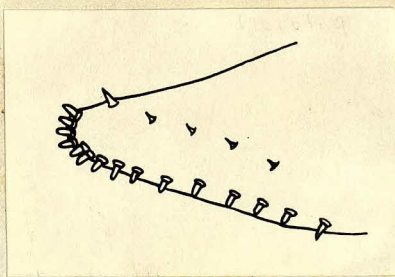


Fig.II-51. The right ovipositor lamella of D.repleta

and ventral sides of the lamellae at an acute angle to each other; the bristles are, again, yellowish and just visible at a magnification of x 60.

These characteristics of the genitalia, together with the characters listed by Burla, should make certain identification possible for European specimens of the repleta group.

D. REPLETA WOLLASTON (1858)

Wollaston (1858: 117) described the species as having a thorax ^{with} very many blackish small spots; testaceous legs and base of the antennae; reddish brown, somewhat ashy wings; and white hatteres. This description could apply to many of the members of the repleta group.

Sturtevant (1921: 99-1?1) gives a description from dried material, and says the abdomen is grey. Later descriptions of live material call the abdomen yellow.

Duda (1935: 94) gives a description which might include the very similar species, D.hydei, because he describes only one species, yet both are known to occur in Switzerland. The strength of the anterior reclinate orbital in his description (very fine) corresponds with D.hydei, and the width of the

cheek (very narrow) seems to correspond more nearly with D. repleta, but the description of the color of the abdomen ("gelb, mit breiten, medial unterbrochenen, lateralwärts sich geradlinig verschmälernden, schwarzbraunen Hinterrandbinden") does not really apply to either of the two species, both of which have bands on the posterior margins of the tergites which are medially interrupted, and become much wider laterally (fig. II-4).

Patterson (1943: 117-118: pl. VII: fig. 32) has an excellent and complete description.

Burla (1951: 115-116) gives a direct translation of Patterson.

D. HYDEI STURTEVANT 1921

Sturtevant (1921: 101) gives a brief characterization, separating this species from D. repleta because it has a 1st coxa which is pale below, and there are no lateral grey areas on the abdominal segments. Sturtevant does not appear to have seen Wollaston's type specimen of D. repleta, but since he believed (collecting in the New World) that only one of the species he saw occurred in the Old World, he applied the name to that species. This is, in fact, untrue, since D. hydei is common in the Old World also. D. hydei and D. repleta have both been used for genetics research, however, and the nomenclature of the various species appears to be agreed upon by present-day

Drosophila workers. Should a re-examination of the type specimen prove therefore that Sturtevant did re-name Wollaston's species and apply the old name to a new species, great confusion in the literature might result. In any case, it would seem preferable to accept the current usage.

Patterson (1943: 126-129: pl. VII: fig. 37) gives an excellent description.

Burla (1951: 116-118) gives a direct translation from Patterson, and differs only in saying 6 instead of 8 rows of acrostichal hairs. The English specimens I have examined agree in all respects with Patterson's description, and have 8, not 6, rows of acrostichal hairs.

FUNEBRIS GROUP

"Reddish brown species; sterno-index about .7; "horn" about 1/5 of puparium; arista with 10 to 11 branches; male abdomen largely shining black." (Sturtevant 1942: 31).

D. FUNEBRIS FABRICIUS 1787

Fabricius (1787: 345) designates the species as Musca funebris. He mentions the plumous antennae, dark head, dark unspotted rufous thorax, clear wings, and black abdomen, with pale margins on the tergites.

Duda (1935: 82-85) gives a detailed description of external characteristics. He calls the carina strong, nasiform, and deep-reaching, which does not correspond with later descriptions (see below). His description of the abdominal coloration agrees with the English specimens I have seen. There is an exception, in that sometimes the dark band on the posterior margin of the tergite of the male (as well as the female) is more-or-less clearly interrupted medially, a character which Duda does not mention.

Patterson (1943: 110-111) gives a description which includes figures and descriptions of the male and female reproductive system, eggs, and pupae. He describes the carina as 'broad flat'. The specimens I have seen show a strong, nasiform, and deep-reaching carina (agreeing with Duda's description) which is, however, flattened on top. Patterson's account does not accurately describe the carina of the English material I

have seen. His details of abdominal coloration do not include the fact that the dark coloring of the tergites of both male and female is often medially interrupted with yellow.

Burla (1951: 113-114) gives a description which differs but little from that of Patterson. His account of the abdominal coloration, however, agrees entirely with the English specimens I have seen.

TESTAGEA GROUP (= SUBGENUS ACRODROSOPHILA DUDA)

"Yellowish or brownish species; a pair of presutural acrostichal bristles; ventral receptacle with no minor coil; fungivorous."
(Sturtevant 1942: 30)

D. TESTAGEA VON ROSER 1840

Duda (1935: 53) gives an extensive description of the external characteristics, although no mention is made of the extreme morphological variation, which seems to be characteristic of this species (see below). He mistakenly considers D. putrida Sturtevant to be a synonym of D. testacea, whereas, in fact, both species occur together in the Eastern United States.

Burla (1951: 111-112) gives a description which is based on that of Duda, but has in addition details of the internal characteristics, eggs, and pupae.

Burla and Gloor (1952: 167) discuss the color variation in this species, which, as they show, may easily cause mis-identification in a key, particularly when the long presutural acrostichal hairs are overlooked. The mesonotum may be yellow or dark brown; the band on the posterior margin of the abdominal tergites may be reduced and resemble D. limbata, or expanded and resemble D. phalerata, D. kuntzei, or even D. histrio; the ocellar triangle may be yellow, or almost black; and the animal may be shining or matt.

IMMIGRANS GROUP (= SUBGENUS SPINULOPHILA DUDA, =
ACANTHOPHILA DUDA)

"Dull yellowish; a row of short thick spines on the first femur; costal index over 3.0; "horn" about half length of puparium." (Sturtevant 1942: 32). "Ventral receptacle short with about twenty-five loosely arranged coils, and sperm pump with two twisted posterior diverticula" (Patterson and Stone 1952: 39).

D. IMMIGRANS STURTEVANT 1921

Sturtevant (1921: 83-84, pl. 3-1) gives a description which agrees reasonably well with the specimens I have found. However, the color plate shows a much darker specimen, with very different markings. This does not agree with either Sturtevant's description, or the English specimens I have seen.

Duda (1935: 54-55) gives a very detailed description. His account of the abdominal coloring agrees most closely with the specimens I have found.

Patterson (1943: 180-182) gives the same description as Sturtevant, but adds illustrations and descriptions of the internal characteristics, eggs and pupae.

Burla (1951: 119-121) departs from Patterson's account in giving the body length of the male as 2.6 - 3.7 mm. (instead of 2.5 mm); and the second bristle as almost as long (instead of over half as long) as the first. The English specimens agree better with Burla's descriptions than with that of Patterson.

MELANDERI GROUP

"These are yellowish species with six or seven branches in the arista, only one prominent oral bristle, acrostichal hairs in six rows, no prescutellars, wings clear, and costal index 3.0" (Patterson and Stone 1952: 32).

Hsu (Burla and Gloor 1952: 168) places D. pallida, a European species, in this group which was previously known to be represented only by North American species. There is some confusion as to the nomenclature of this species (see below).

D. CAMERARIA HALIDAY 1847

Haliday (1847: 174) described a new species, D. cameraria, having an opaque testaceous thorax, with a fuscous stripe; and red abdomen with fuscous furrows (edges of the tergites?).

Basden (1952: 201) gives D. pallida as a synonym for D. cameraria. He examined Haliday's type specimen, but not that of Zetterstedt.

Zetterstedt (1847: 2971) gives a brief type description of D. pallida. His species has, among other things, a shining yellowish thorax, with a dull brown median line; and a yellow abdomen occasionally with a brown anus. In his discussion of the species, he says that it is closely related to 'D. graminum', and says it is among the smallest of the genus.

Duda (1935: 91-92) gives a detailed description of D. pallida Zetterstedt, and this agrees exceedingly well with specimens of D. cameraria Haliday (identified as such by E. B. Basden) which I have caught.

Burla (1951: 124-125) gives a description of D.pallida which, since he caught only one individual of this species, is based almost entirely on Duda's description.

Burla and Gloor (1952: 167-168) add further details of the internal and external morphology of D.pallida. According to these authors, Hsu places the species in the melanderi group because of the structure of the external male genitalia.

I have specimens of D.cameraria Haliday, identified by E.B.Basden, who has seen the type specimen, and it seems certain that it is identical with D.pallida described by Duda and Burla. The former species corresponds exceedingly well with the descriptions of the above author, and the external male genitalia resemble those of D.melanderi illustrated by Hsu (1949: pl.XV-1). Whether this is the same as D.pallida Zetterstedt cannot, however, be determined with certainty, except by re-examination of the type specimen, since the type description is so brief.

UNCLASSIFIED SPECIES

D. HISTRIO MEIGEN 1830

Meigen (1830: 85) describes this species as having a brick-red thorax, and yellow abdomen with pairs of black triangular spots. His diagnosis is extensive enough to make it quite certain which species he was referring to.

Duda (1935: 85-86) has an excellent description of external characteristics.

Burla (1951: 121-123) gives a more complete account, including internal characteristics, and a discussion of the relationship of this species to other members of the genus.

D. VIBRISSINA DUDA 1924

Duda (1924: 219) gives a key, but no description.

Duda (1924 b: 297-299) gives a detailed description, with a very poor illustration of the posterior half of the abdomen of the male.

Duda (1935: 99-100) extends the above description, adding details of the orbital bristles, and giving an illustration of the shape of the female ovipositor lamella, which he describes as plow-share shaped.

Burla (1952: 619-723) describes a new species, D. grischuna, indicating its great similarity to D. vibrissina Duda. Duda described D. vibrissina from specimens caught in Hungary and Bohemia, and did not find it in Germany. Furthermore, there are differences between the Swiss specimens and Duda's description.

For these reasons, Burla concludes that the species he found is a new one, and names it D. grischuna. He distinguishes D. vibrissina and D. grischuna by the following characteristics.

<u>D. vibrissina</u>	<u>D. grischuna</u>
Ocellar triangle lighter yellow than the forehead	Between the ocelli brown
2nd orbital standing close behind the 1st	Relatively far behind the 1st
5th and 6th tergite of the ♀ all yellow	With a band on the posterior margin, as the 2nd through 4th tergites
Posterior margin of the 6th tergite of the ♂ with a fan of dense long black bristles, in the ♀ sparsely bristled.	♂: 6th tergite not noticeably differently bristled than the 5th tergite, and about equally strongly bristled as the 6th tergite of the ♀
A dorsobasal notch on the ovipositor lamellae of the ♀	Notch lacking
Femur of the 2nd pair of legs ventrally with long bristles	Lacking

In my collections, I have found numerous representatives of a species to which the descriptions of both Burla and Duda might well apply, except that it is smaller than D. grischuna. The female ovipositor lamellae are identical with those illustrated by Burla (fig. 1), while the external and internal morphology also seem to correspond fairly closely with the

species described by Burla. (My examination was of specimens preserved in alcohol, however, and the coloring and exact shape of the internal organs is not easy to determine.) I do not consider the differences between Duda's description and the species caught by Burla to be as significant as the latter author believed. Thus, among flies caught at the same locality, I have found one with a light yellow, and one with a dark brown ocellar triangle. The band on the posterior margin of the 5th and 6th tergites of the female was much reduced in many individuals, so that in dried specimens, those tergites might look entirely yellow. Again, the long dark fan of bristles to which Duda referred might well be on the ventral rather than the dorsal part of the tergite, for the 6th tergite appears to be expanded ventrally, and this ventral projection does have a dense fan of bristles. (Duda's illustration of the male abdomen (1924 b: fig. 30), though not very clear, tends to confirm this.) The ovipositor lamellae of the female do not possess a clear notch dorsobasally, but the colored chitinous part does fall away abruptly, leaving a transparent continuation, and since Duda apparently only examined dried specimens (never having caught the species himself), he may well have been mistaken in his description of this character. We are left, therefore, with only two of the six characters by which Burla distinguished his species (D. grischuna) from Duda's description (D. vibrissina). It seems unlikely, therefore, that they represent different species, but this cannot be determined with certainty until Duda's type specimen can be examined.

D. MACULARIS VILLENEUVE 1921

Villeneuve (1921: 159) gives a rather brief description of D. macularis, the salient features of which are that the abdomen is characterised as having four rows of black spots, the median ones forming large spots, sometimes merging; the pleurae have two blackish horizontal stripes; and the posterior transverse vein of the wing is darkly, often narrowly, shaded.

Duda (1935: 88-89) gives an extensive description of "D. macularis Villen", but describes the abdomen as having four black spots and one central, narrow, black longitudinal stripe, the pleurae as having one brown longitudinal stripe, and the posterior transverse vein of the wing as being not, or scarcely noticeably, shaded. It is quite possible that this is not the same species as the one described by Villeneuve.

I have no Drosophila which corresponds either to Villeneuve's or to Duda's description, although D. macularis has been reported from Great Britain. (Kloet and Hincks 1945: 401). Thus, I have had to include D. macularis in my key on the basis of the contradictory descriptions of Duda and Villeneuve. It is keyed, therefore, under species both with and those without clouded cross-veins; and is once described as having two blackish stripes on the pleurae, the other time as having one brown pleural stripe. Although this procedure does not make for clarity, it is, unfortunately, the only course open.

FENESTRARUM GROUP

There are three closely related species, of which two, D. forcipata and D. acuminata, have only recently been described by Collin (1952: 197-199) and separated from D. fenestrarum Fallen (1823: 6). Collin distinguishes the three species primarily by the shape of the male genitalia, and gives illustrations of the differences. Duda (1935: 81-82) and Burla (1951: 123-124) both describe D. fenestrarum, but both may, in fact, have been describing at least two species under the one name. However, since Collin's descriptions are not only very brief, but also inadequate for the purposes of constructing a key, and since I only caught one specimen of D. forcipata, and none of the other two species, I cannot give a key or even the characteristics which distinguish the three species. In this situation, all that is possible is to refer the reader to Collin's article.

CHAPTER III

COLLECTING METHOD AND DISTRIBUTION

NOTE: The collecting data on which this chapter is based is given in full in appendices I and II.

INTRODUCTION

The distribution of Drosophila in the neotropical and nearctic zones has been extensively studied by Patterson, Dobzhansky, Spencer, and many others. The Old World species of this genus were, on the other hand, almost entirely neglected by modern systematists until Burla began his studies of the Swiss Drosophila. Since then, a series of similar studies have been made, many of which are still in progress. Lever and Sobels have made collections in Holland; Herting is working on Drosophila systematics in Germany; Hadorn and his colleagues have collected in parts of France, Spain and Portugal; Basden is investigating British Drosophila, but mainly confining his attention to collecting in Scotland, Ireland and Northern England; and I have made collections in Southern England. The distribution of the palaeartic species of Drosophila, at least in Western Europe, promises soon to become as well known as the New World distribution.

The distribution here discussed is based on collections, made over the past two years, and confined to Southern England. There seemed two excellent reasons for this; firstly, extensive data for a smaller area promised to be of greater use than sparse data for a wider area; secondly, Northern England is more readily accessible, as a collecting ground, for Drosophila workers in Scotland. An attempt has been made to cover the many distinctive

areas of Southern England. For example, collections were made in East Anglia in the fens, breckland, broads, and the farmlands; the New Forest, with its different types of woodland habitats, both natural and planted, was chosen for Hampshire; while in Devon, collecting sites included natural woods and planted gardens with palms, bamboo, and other tropical plants. A standard collecting method, which is described below, was used in all investigations.

COLLECTING METHOD

For any extensive zoological sampling, there are two aims which are not always compatible; to collect the most specimens in the shortest time, and to obtain a representative sample of the fauna being studied. Recent Drosophila workers, by using baited 'traps' of various sorts, appear to have emphasised the first aim to the detriment of the second. Even so, a vast amount of information has been amassed by this method, while it is by no means certain that other methods (such as sweeping, breeding from various substances found in nature, and finding large numbers which happen to be swarming) provide any more accurate picture of the true frequency or distribution. In fact, since the numbers caught are so much smaller, the presence of a species is far less likely to be recorded.

Although basically the method is to attract the flies with bait of a fermenting substance and then collect them from

the bait, each worker has devised a variation most suited to the particular environmental conditions with which he is dealing. Thus, where populations are relatively large, and there is a ready means of transport, the method used by Patterson, and, with slight modifications, by Burla, is the most efficient. This method utilizes a large tub with bait, and the flies are caught by means of a net (Spencer 1950: 545-546, Burla 1951: 30). Spencer (1950: 541-545) uses small cups with bait which are hung on trees, and removes the flies by disturbing them so that they fly into a 'collector'. Dobzhansky, for his California collections, used paper cups in wire stands, and collected the flies by means of a glass funnel. I have used a modification of the methods of both Spencer and Dobzhansky, since experience gained assisting these workers showed that certain parts of each method had particular advantages for my study. It was important for the equipment to be readily portable: it was also desirable to secure all the flies which visited the bait, since the total fly population in England (judged by the number of flies visiting the cups) appears to be very small in comparison with that in California. Fig. III-1 shows the apparatus.

Waxed paper cups about 2" in diameter and 4" deep were filled to a depth of about $1\frac{1}{2}$ " with fermenting fruit. These were hung at a 45° angle by means of a string on trees about

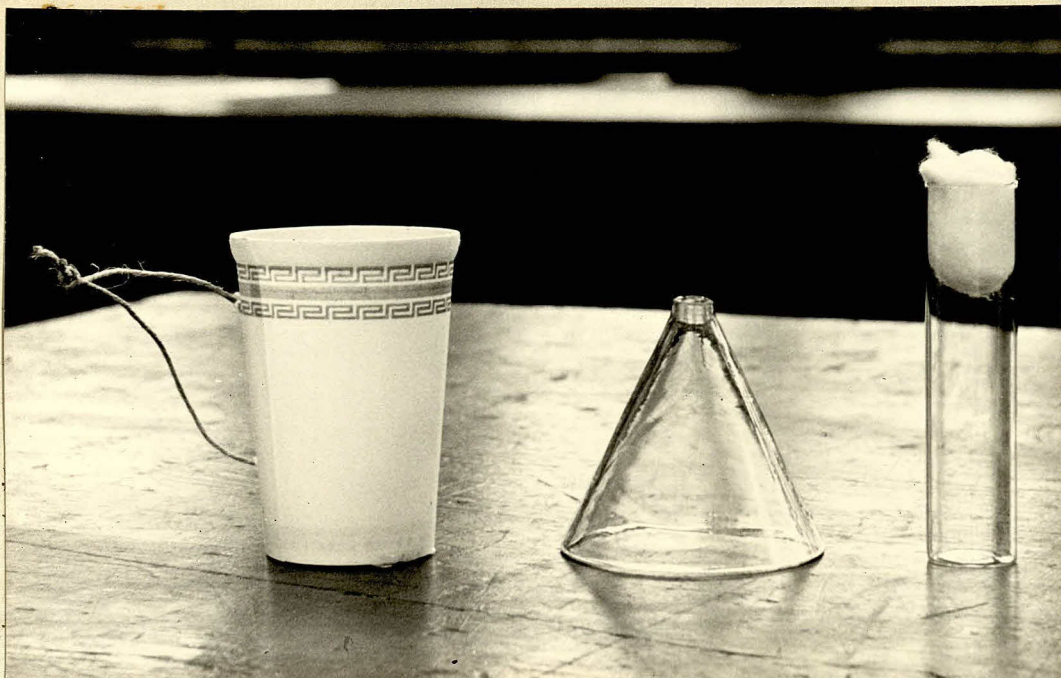


Fig. III-1. Collecting apparatus: a waxed paper cup with bait, a short-stemmed glass funnel, and a glass specimen tube with cotton wool.



Fig. III-2. The collecting apparatus, showing position for use in removing flies.

10 meters apart. (Where there were no trees, they were placed on the ground.) In all but a few cases, the cups were set out the evening before the intended collections. Mashed bananas were used as bait wherever possible; however, sometimes they were difficult to obtain, and pears had to be used instead. Since this may well make some difference in the relative proportion of flies caught (Hedorn et al. 1951: 136-137), different baits were never used where detailed comparisons of frequency were to be made. The cups were visited every 1 to 2 hours, beginning in the early afternoon. The flies were removed by placing the wide end of a short-stemmed funnel over the mouth of the cup (held at a 45° angle), and a vial over the narrow end of the funnel (fig. III-2) and tapping the cup. The flies, being positively phototropic and negatively geotropic when startled, fly upward and enter the vial. The results obtained by this method are comparable with those of Burla and others. However, the yellow species (the quinaria group and others) seem to be less phototropic than the dark species of flies (obscura group and D. deflexa, and (particularly late in the evening) tended to stay on the bait. With my method, it was possible to see these flies and catch them; whereas by Burla's method, they might well be overlooked.

Burla (1951: 132-133) gives the following possible factors which might alter the uniform effectiveness of a particular bait. My data confirms his criticisms.

- a. The relative frequency of various species alters with time of day (see Chapter IV).
- b. The weather probably affects differently the activity of different species (p. 129).
- c. Some flies are more active than others, and therefore can find the bait better. (This effect would probably be more serious in Burla's method of collecting, where a few large tubs were used, rather than when many small cups.)
- d. Differences in food preference between species produce differences in their reaction to bait. (This was very strikingly shown in a collection made July 19, 1952 in Wytham Woods, Berkshire, where there were several hundred D. vibrissina swarming around a tree fungus, Polyporus, yet in the cup nearby, filled with fermenting fruit, there were only flies of the obscura group).
- e. Bait is probably more effective in a woodland than in an orchard, where there is a great deal of fermenting fruit already.

In addition, the bait changes in composition from day to day, as the fermentation processes progress.

It is not possible, therefore, to make a study of the actual frequency of the different species of Drosophila. Even so, much information can be gained about the distribution, and habitat preference; and it is certainly possible to compare the relative frequency of a particular species in different localities and in different countries.

TOTAL NUMBER CAUGHT NO OF ENGLISH LOCALITIES % IN ENGLAND % IN SWITZERLAND
WHERE COLLECTED

SPECIES	TOTAL NUMBER CAUGHT	NO OF ENGLISH LOCALITIES WHERE COLLECTED	% IN ENGLAND	% IN SWITZERLAND
subobscura	10,022	29	54.1%	21.3%
obscura	4,013	28	21.6%	15.9%
tristis	848	25	4.6%	0.6%
ambigua	71	11	0.4%	1.2%
obscura-X	143	12	0.8%	0.1%
helvetica	186	9	1.0%	5.4%
bifasciata	--	--	--	1.1%
alpina	--	--	--	0.8%
deflexa	1,039	18	5.6%	0.7%
phalerata	1,160	26	6.3%	4.1%
kuntzii	379	14	2.0%	2.6%
transversa	45	8	0.2%	0.3%
limbata	--	--	--	0.2%
melanogaster	87	18	0.5%	14.2%
simulans	--	--	--	+
funebriis	201	24	1.1%	9.9%
busckii	23	4	0.1%	0.1%
immigrans	6	3	+	+
hydei	6	2	+	1.6%
repleta	--	--	--	+
testacea	--	--	--	12.2%
histrio	49	5	0.3%	3.7%
cameraria	219	14	1.2%	--
vibrissina	15	6	0.1%	+
littoralis	8	3	+	2.2%
forcipata	1	1	+	--
fenestrarum	--	--	--	+
unimaculata	--	--	--	0.2%
other Drosophilids	14	7	0.1%	0.3%
TOTAL	18,535	29	100.0%	98.7%

TABLE III-1. The numbers and percentages of the species caught in woodland and scrub habitats in England, during the summers of 1952 and 1953, as compared to collections made by Buria in Switzerland in the summer of 1947. + indicates a percentage of less than 0.1

SPECIES	ITALY	SWITZERLAND	SPAIN	PORTUGAL	FRANCE	HOLLAND	GERMANY	HUNGARY	SCOTLAND	IRELAND	ENGLAND	OTHER LOCALITIES	GENERAL COMMENTS
subobscura	+	+	+	+	+	+			+	+	+	Sweden	
obscura	+	+	+	+	+	+			+	+	+	Sweden	
tristis	+	+	+	+	+	+			+	+	+		
ambigua	+	+	+	+	+	+			+	+	+		
obscura-X		+							+	+	+		
helvetica		+	+	-	+	+			-	+	+		
bi-fasciata	+	+	+	+	+	+			-	-	-	Japan	
alpina		+	-	-	-	-			-	-	-	Japan	
deflexa(=guyenoti)		+	+	-	+	+	+	+	+	+	+		
rufifrons(=nitens)		+	+	+	+		+	+	-	-	+	Austria	
phalerata		+	+	+	+	+			+	+	+	Common all over Europe	
kuntzei		+	+	-	+	+	+	+	-	-	+		
traversa ^{ns}		+	+	-	+	+			+	+	+	Common all over Europe	
limbata		+	+	-	+	+	+	+	-	-	+	Russia	
histrionic		+	+	-	+	+	+		-	-	+	Austria	
cameraria (=pallida Duda)	+	+	+	+	+	+	+	+	+	+	+	Albania, Corsica.	
vibrissina		+1.	+1.	-	+1.			+	-	-	+	Bohemia	
littoralis	+	+	+	+	+	+	+		+	+	+		
macularis		-	-	-	+	+	+	+	-	-	+*	Austria	
fenestrarum-group		+	+	+	-	+	+		+	+	+		
immigrans		+	+	-	+	+			+	-	+	North America, Hawaii	
melanogaster		+	+	+	+	+			+	+	+	North and Central America, Australia, Africa	Cosmopolitan, widely distributed in Europe
simulans		+	+	+	+				+	-	+*	North, Central, South America and Europe	
funnebris		+	+	+	+	+			+	+	+	Africa, Australia, N. America, Mexico	Cosmopolitan, widely distributed in Europe
repleta		+		+		+			-	-	+*		
hydei		+	+		+				+	-	+		
testacea		+	+	-	+	+			-	-	+*		
busckii		+	+	+	+	+			+	-	+	North America, Mexico, Africa, Japan	Cosmopolitan, widely distributed in Europe

Table III-2. The world-wide distribution of those species of *Drosophila* found in Great Britain. + denotes the occurrence of the species in the country concerned. - denotes the absence of the species in the country concerned. * denotes the species on the British check list which have not occurred in my collections. Blank spaces denote lack of adequate data

Note: The use of - indicates the probable absence of the species, i.e., intensive collections have been made in such a way as to indicate their presence if they actually occurred. (Though it must be remembered that such collections may have been made at an unsuitable time of year).

1. *D. grischuna*, reported from Switzerland, Spain and France, is almost certainly the same as *D. vibrissina* (p.)

GEOGRAPHICAL DISTRIBUTION

During the summers of 1952 and 1953, collections were made in many different areas of England, including woodland and scrub habitats, open meadows, and sites on farms and around houses. I shall discuss the general distribution of the various species of Drosophila in the woodland and scrub habitats since in the meadow, the vast majority caught were one species only (D. subobscura) and in the collections around houses, a large proportion of introduced cosmopolitan species appear. Fig. III-3 shows the location of those collections made in woodland and scrub habitats (corresponding to Burla's "Wildbiotop"). The collections were made in East Anglia (localities 1-10) in May and late August, 1952; at Chippenham and Wicken Fen (11 and 12) in early June, 1952; in Kent and Sussex (13-15) in the latter half of June, 1953; in the New Forest (16) in the middle of June, 1952; in Somerset, Devon and Cornwall (17-21) in early August, 1952; in Gloucestershire, Monmouthshire, and Herefordshire (22-26) in the latter half of July, 1953; in Wytham Woods, Berkshire (27) in the middle of July, 1952; and in Bagley Woods, Berkshire, in early July, 1953. Table III-1 shows the number caught of each species, and compares the percentage of different species caught in Switzerland and England. Table III-2 shows the world-wide distribution of the species found in Great Britain. In the following section are

maps showing the distribution in Southern England of the 12 species of *Drosophila* which occurred most frequently in my collections: *D. helvetica*, *D. subobscura*, *D. obscura*, *D. tristis*, *D. ambigua*, *D. obscura-X*, *D. phalerata*, *D. kuntzei*, *D. melanogaster*, *D. funebris*, *D. cameraria*, and *D. deflexa*.

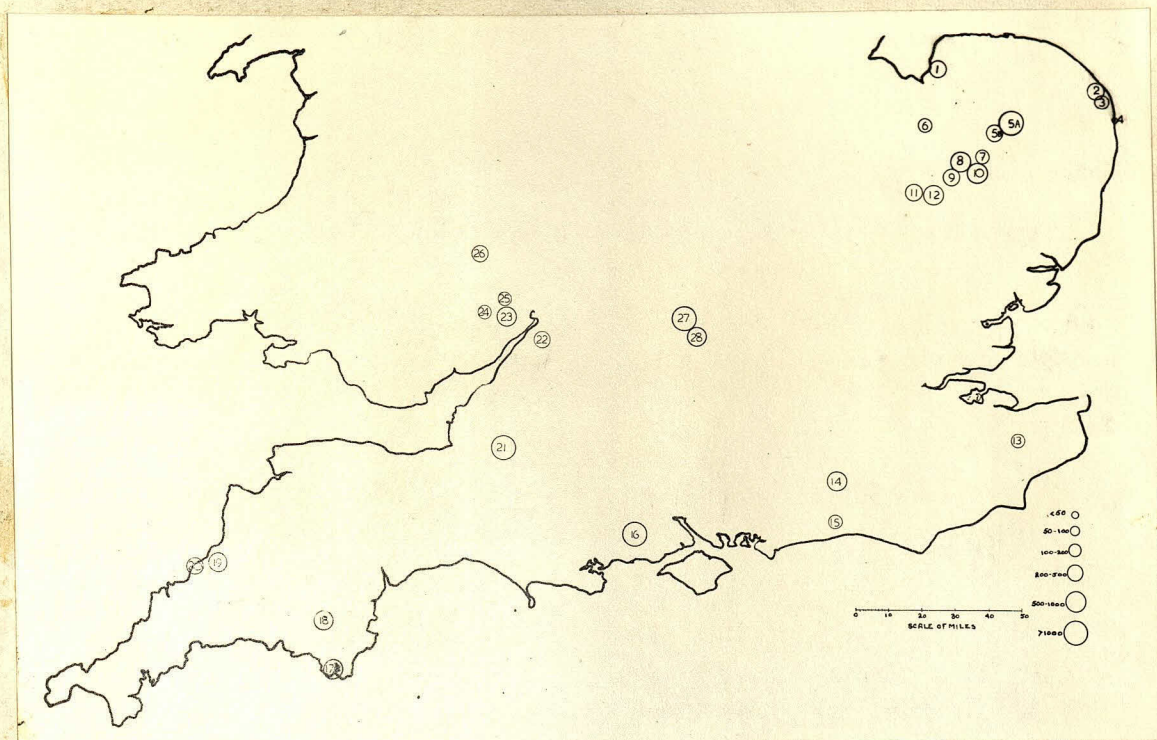


Fig. III-3. Collecting localities in Southern England. The size of the circle represents the total size of the collection.

NORFOLK

1. Two woodlands near Sandringham: one open with tall pines and bracken and rhododendron undergrowth, the other moister and more dense with birch and pine trees.
2. Swampy meadow near Thurne; sedge, hawthorne, willow, pussy willow and blackberry; near farm.
3. Long Filby Broad: meadow with high reeds; marshy woodland with small willows and large oaks and sycamore.
4. Beach near Yarmouth: scrub grass above sea wall.
5. A. Wood along Scoulton Mere: oak, pine, beech with rhododendron
B. Swampy island in Scoulton Mere: oak, willow, birch and beech

6. Fenland near Downham Market: small wood with sycamore, oak and birch; ground cover daffodils; near farm.

7. Pond between Thetford and Watton: reeds; a grove of birch; dense bracken ground cover; occasional hawthorn; and small willows.

8. A long grove of old trees near Thetford: mostly large oaks; also pine, and spruce. Ground cover very sparse; dense canopy; houses and chickens nearby.

SUFFOLK

9. Open meadow near Mildenhall: birch and small oaks spaced far apart; no canopy; bunch grass ground cover; picnic ground.

10. Pine plantation: trees about 15' apart and 8" diameter; ground cover moss.

CAMBRIDGESHIRE

11. Wicken Fen: willow, alder buckthorn, grass, sedge.

12. Chippenham Fen: a marshy wood of pine, birch, oak, elm, and hazel; and a meadow with sedges and rushes, and copses of trees.

KENT

13. Woodland near Wye: dark, dry beech woodland on downland hill; farm nearby.

SUSSEX

14. St. Leonard's wood near Horsham: three woodland localities; one of old beech and oak trees; one a scrub wood of beech, holly, ash and birch; and one a mixed wood of large pines, oak, and beech with moss and rhododendron undergrowth.

15. Scrub copse on South Downs near Washington: hawthorne and hazel forming a dense small copse with no undergrowth; cows grazing.

HAMPSHIRE

16. New Forest near Burley: 7 woodland localities (see p. 127).

DEVON

17. Overbecks, Salcombe: oak wood and two planted gardens with palms, bamboo, and other imported plants.

18. Brentmoor near South Brent: along a rocky Dartmoor stream with trees and bracken; spruce, fir, larch, juniper, pine, oak, ash, and rhododendron.

CORNWALL

19. Along a polluted stream near Oterham: beech, sycamore, oak; dark and damp; farm nearby.

20. Along stream near Tintagel; willow, hawthorn, sycamore, lime tree, and bracken.

SOMERSET

21. Hillside near Wells: two dry hillside woodlands (see p. 126).

GLOUCESTERSHIRE

22. Quinchcombe Hill near Dursley: large beech and oak trees with ash and hawthorne; dense canopy; no undergrowth; very steep slope.

23. Forest of Dean near Coleford: three dry woodland localities; one an open woodland with large oak trees; the other two dark, one a larch plantation, the other an oak plantation.

25. Mixed woodland near Symond's Yat: large oaks, beech, holly, larch;

rhododendron.

CORNWALL

19. Along a polluted stream near Otterham: beech, sycamore, oak; dark and damp; fars nearby.

20. Along stream near Tintagel; willow, hawthorn, sycamore, lime tree, and bracken.

SOMERSET

21. Hillside near Wells: two dry hillside woodlands (see p. 126)

GLOUCESTERSHIRE

22. Stinchcombe Hill near Dursley: large beech and oak trees with ash and hawthorne; dense canopy; no undergrowth; very steep slope.

23. Forest of Dean near Coleford: three dry woodland localities; one an open woodland with large oak trees; the other two dark, one a larch plantation, the other an oak plantation.

25. Mixed woodland near Symond's Yat: large oaks, beech, holly, larch; bramble undergrowth.

MONMOUTHSHIRE

24. Grove in pasture near Monmouth: small trees; beech, ash, hawthorn; several muddy ponds.

HEREFORDSHIRE

26. Oak woodland near Eardisley: tall and straight oak trees forming little cover; bramble undergrowth.

BERKSHIRE

27. Wytham Woods: two woodland localities (Figs. IV-5A and IV-5B)

28. Bagley Woods: six woodland localities (Figs. III-17A -III-17F).

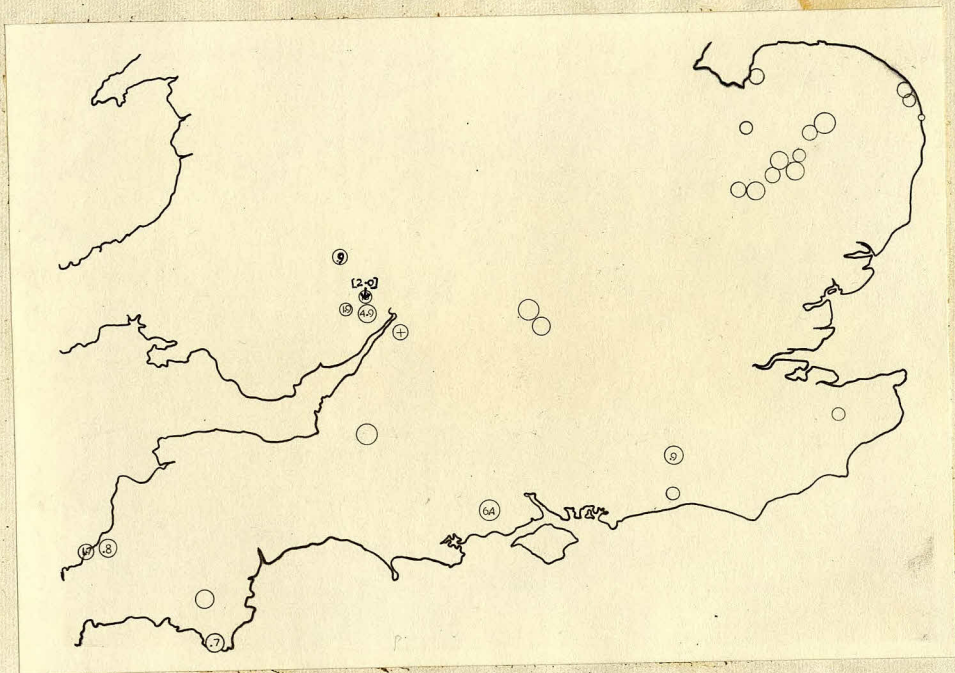


Fig. III-4. The distribution of *D. helvetica* showing that this species does not occur in Eastern England. (Although the woodland collection in Kent (13) was small, a total of over 1000 specimens of *Drosophila* were caught in orchards and garden, and there were no *D. helvetica*.) In Gloucestershire (22), it did not occur in the woodland, but was found in a nearby orchard. (+)

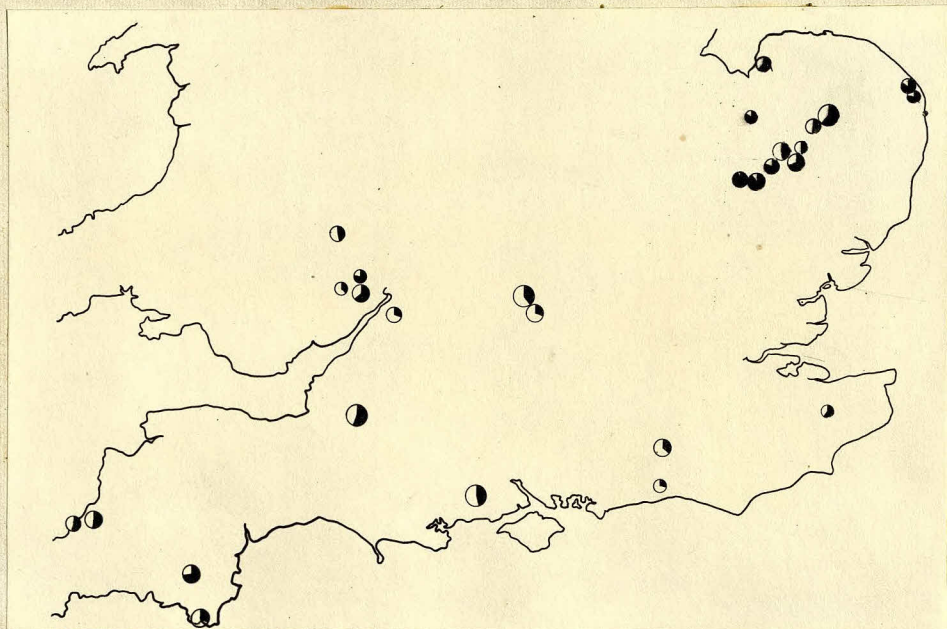


Fig. III-5. The distribution and percentage of *D. subobscura*, showing that this is the most common species in almost all localities.

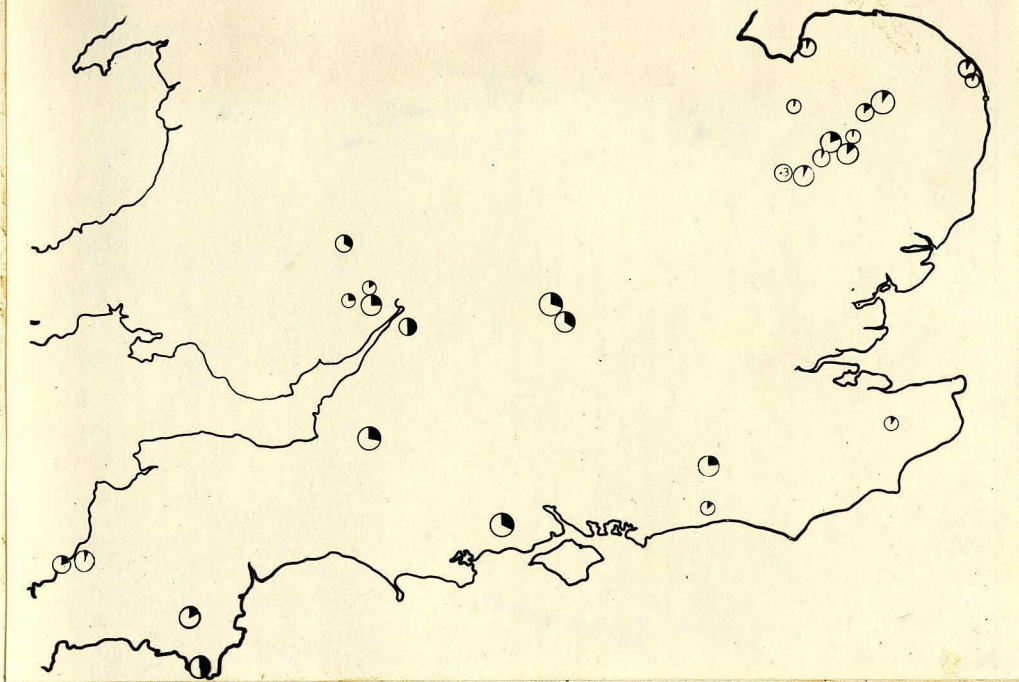


Fig. III-6. The distribution and percentage catch of D. obscura, showing that this species occurs in relatively high numbers everywhere, except in locality 4, which is a grassland along a beach. The smaller proportions of this species in East Anglia is probably due to the time of year when collections were made (see p.131).



Fig. III-7. The distribution of D. tritigis, showing that this species was caught with a relatively low frequency in all areas of Southern England, though not in all localities.

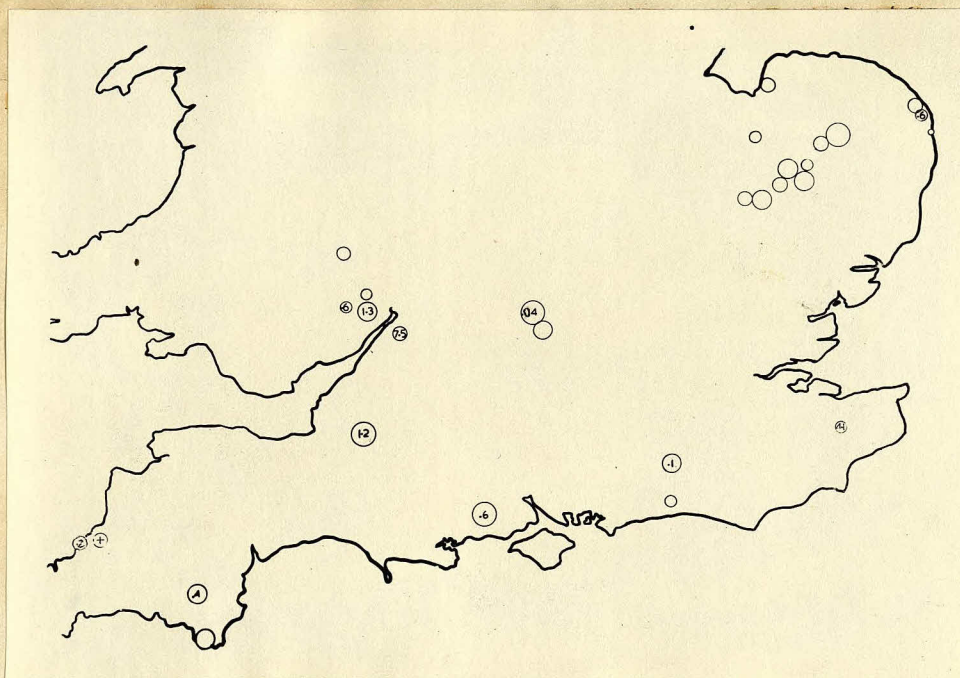


Fig. III-8. The distribution of D. ambigua. It seems that this species occurs with a lower frequency in Norfolk, but it is difficult to know if this is because collections were made ^{only} in early spring and late summer.

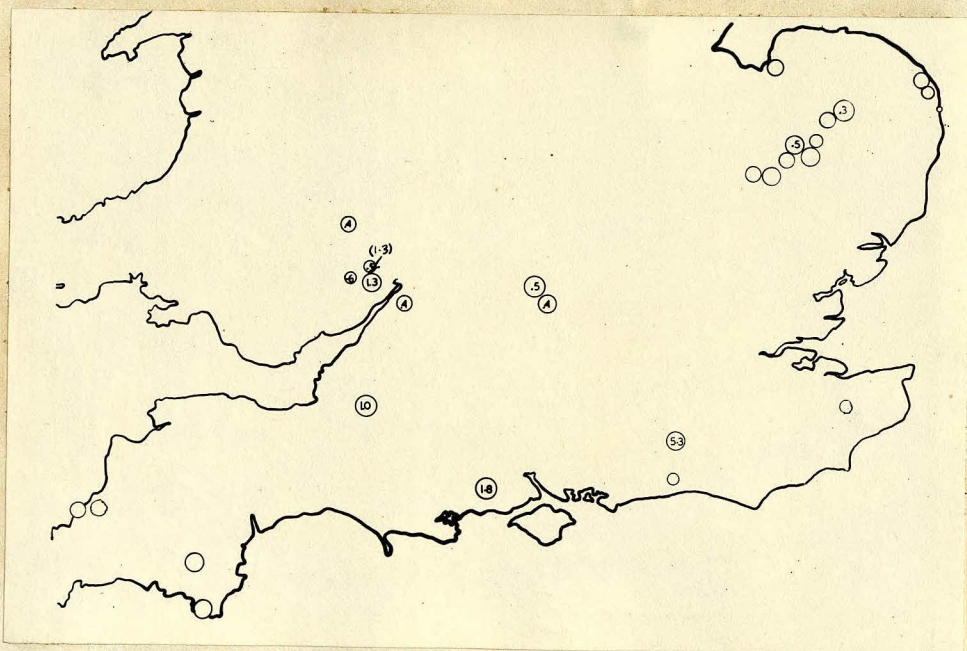


Fig. III-9. The distribution of D. obscura-X, showing that this species is widely distributed in Southern England, but occurs with a very low frequency.

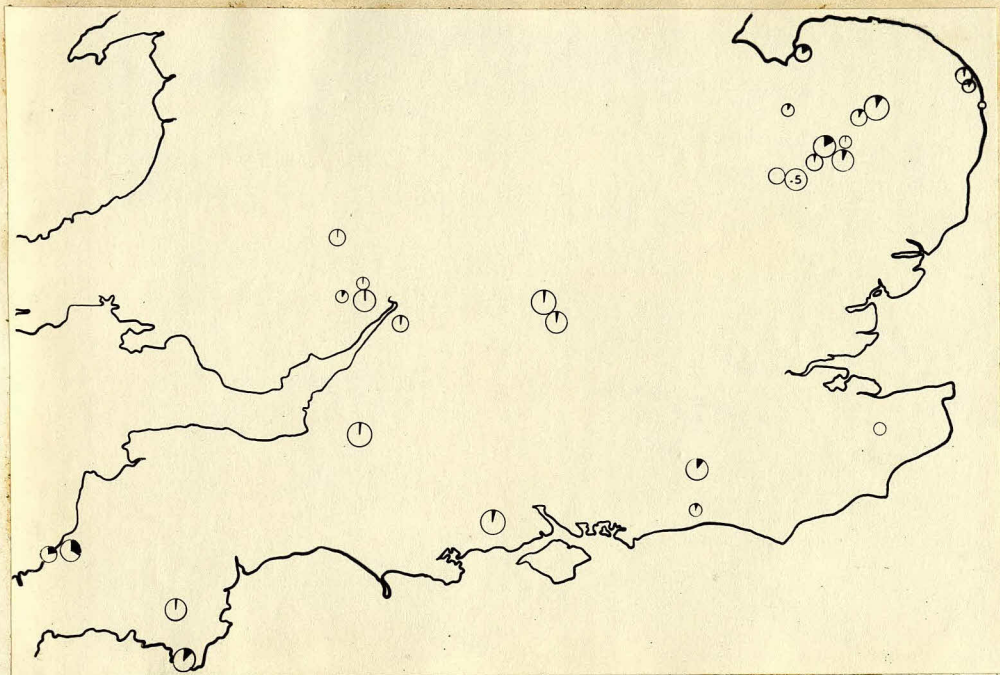


Fig. III-10. The distribution of *D. phalerate*. This species occurs quite frequently in all areas of Southern England, although not in all localities.

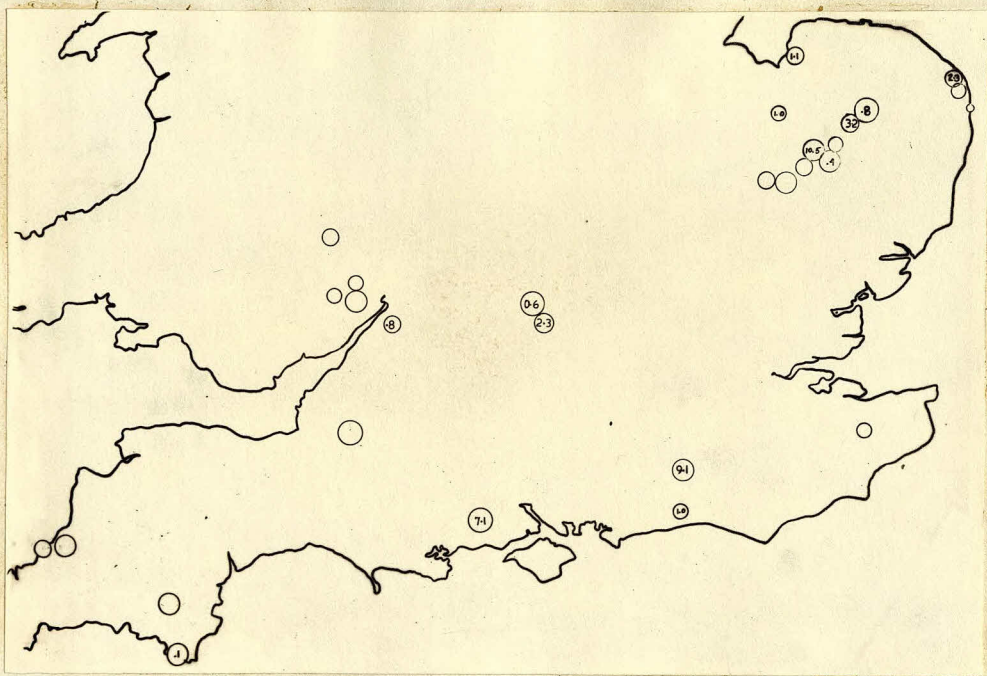


Fig. III-11. The distribution of *D. kuntzei*, showing that this species occurs with low frequencies in all areas of Southern England.

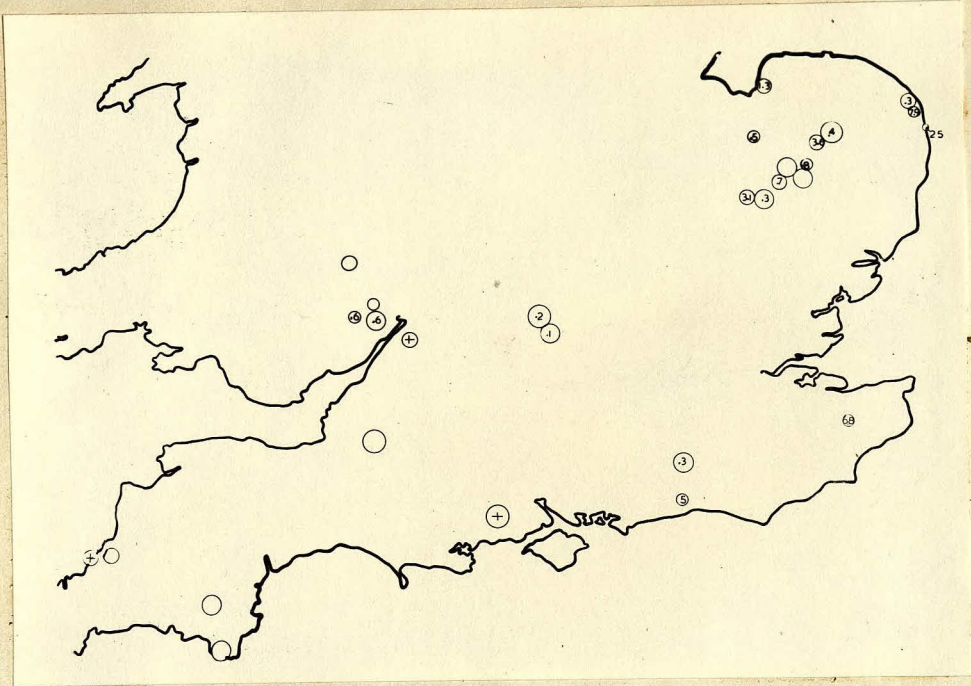


Fig. III-12. The distribution of D. melenogaster. This occurs at a low frequency in most woodland habitats. It is difficult to understand why it was caught at only one locality in Somerset, Devon, and Cornwall.

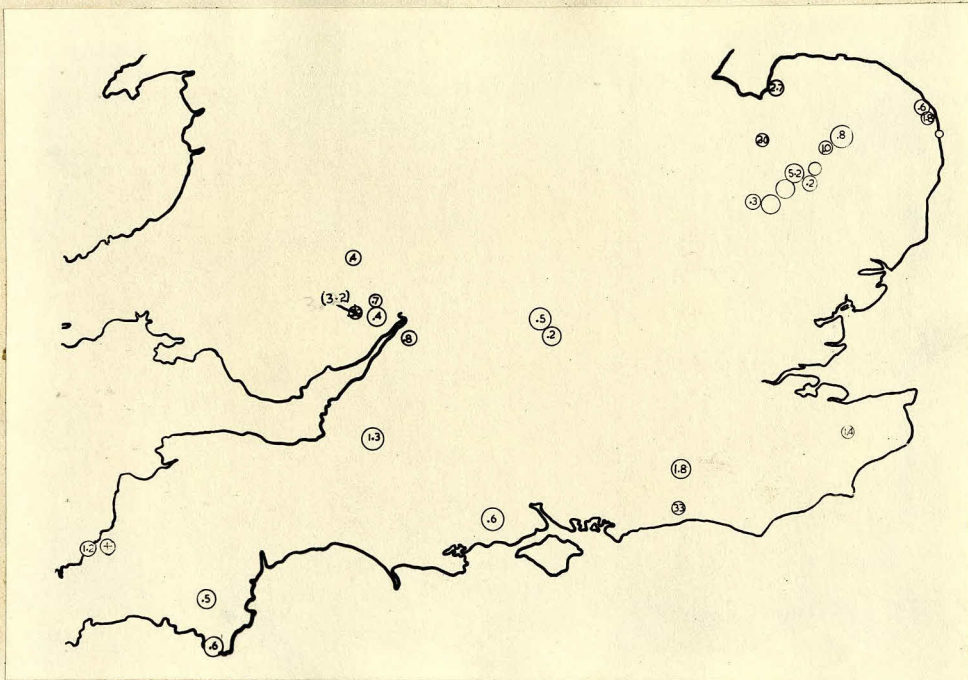


Fig. III-13. The distribution of D. funebris, which is very widespread, though not common in woodland habitats.

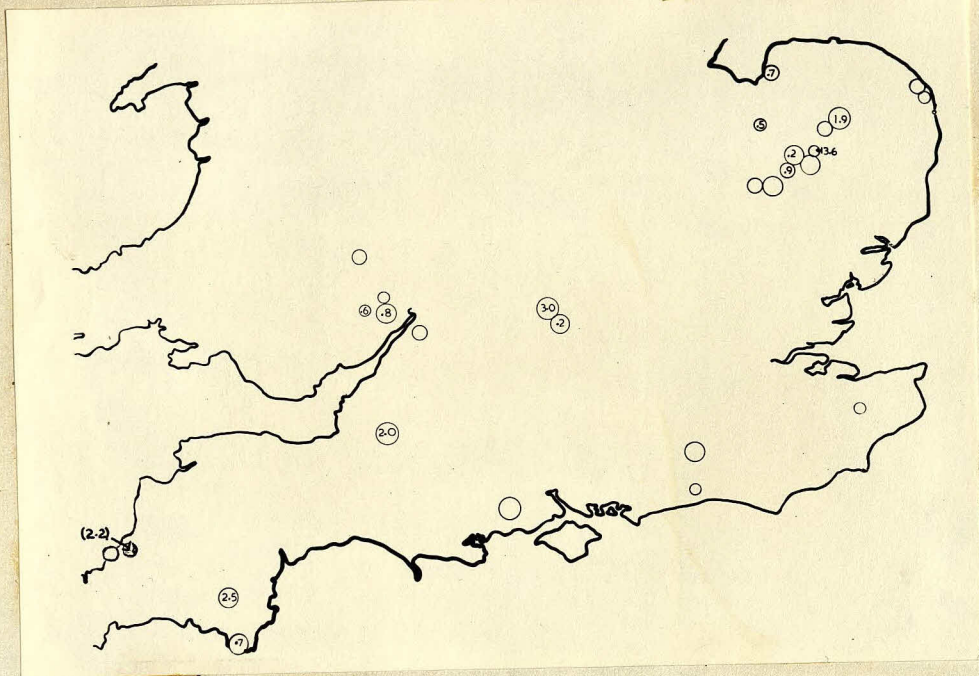


Fig. III-14. The distribution of D. cameraria, which is widespread in Southern England. Since this species is most active just before dusk and just after dawn (Chapter V), it is probable that it was not caught in some localities where it does, in fact, occur.

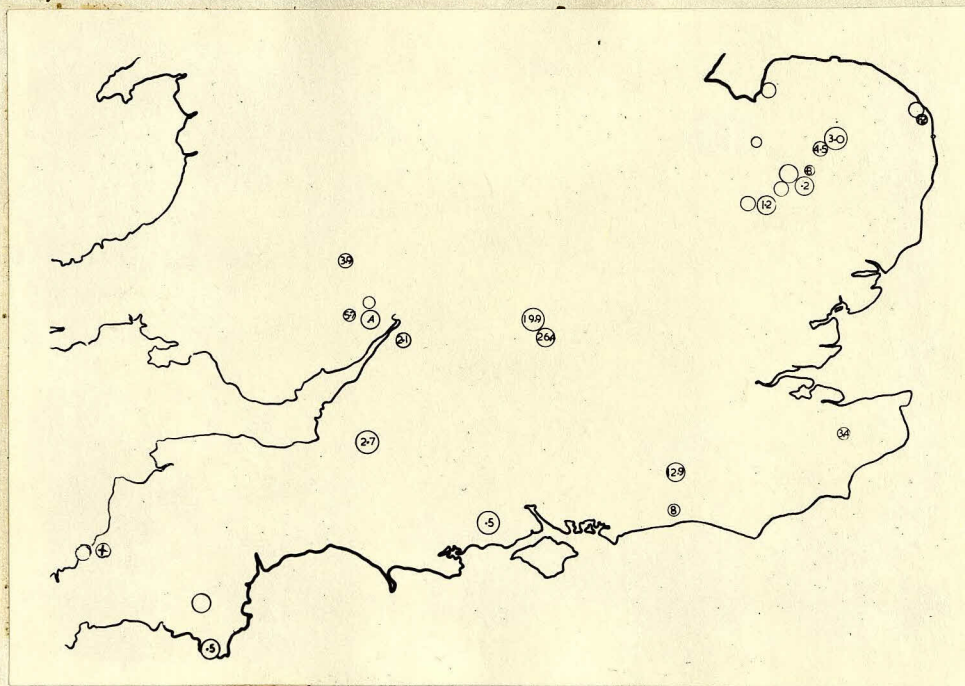


Fig. III-15. The distribution of D. deflexa, which occurs in all areas of England. Since there is a great increase in the numbers of this species during July and August, very little can be determined from my collecting data about its relative frequency in different areas of Southern England.

The remaining species (i.e. those for which distribution maps are not given) were found in such small numbers in woodland habitats that it is difficult to assess their distribution with accuracy. The cosmopolitan D. busckii occurred in very large numbers in Norfolk, especially around houses and on farms, and was found in four of the eleven woodland habitats 1, 2, 5A, 5B. Only five individuals were caught in other areas, three on a farm in Wytham; and two in the garden of an Oxford house. A total of six individuals of D. immigrans, another cosmopolitan species, were found in woodlands in Cornwall (20), Sussex (15), and Berkshire (27); and six individuals were found on a farm in Norfolk, and one in a garden in Oxford. A total of 46 individuals of D. hydei, a third domestic and cosmopolitan species, were found, six in woodlands and forty on farms and around houses, in Norfolk (1, 2, 5), Kent (13) and in Oxford. D. histrio was found in five localities, in Suffolk (9), Sussex (15), Hampshire (16), Devon (17) and Gloucestershire (23). D. transversa was caught in 8 of the 13 woodland localities in East Anglia (1, 2, 5A, 5B, 7, 8, 9, 11). It has also been found in meadows in the New Forest (16), and Wytham Woods (27). This species formed over 43% of the total number of flies caught in locality 7, Norfolk, on May 2, 1952: but in August, made up only 1.7% of the total Drosophila caught in the same locality. D. vibrissina has been caught in East Anglia (5A, 8), Somerset (21), Hampshire (16), Devon (17),

and around Oxford, both in Wytham and Bagley Woods (27 and 28) (although not in those Oxford collections which have been summarized in the preceding section). The low numbers caught are no indication of the frequency of this species, since it is a fungus feeder, and apparently not much attracted to fruit bait (see p.). D.littoralis was caught infrequently in wet places, in Norfolk (5A and 5B), Sussex (14) in a woodland along a stream, and also at Cothill, near Oxford. The only specimen of D.forcipata was caught near Tintagel, Cornwall (20) along a stream lined by bramble, bracken and other scrub. The remaining two species in my collections, D.limbata and D.rufifrons, did not occur in the woodlands included in the above summary. A total of eight individuals of D.limbata were caught; three in a meadow with hawthorn wood in Wytham Woods, in late April, 1952; three near Oxford houses in early May and late November, 1953; and one in a small grove of spruce trees (Bagley II) in June. One specimen of D.rufifrons was also caught in this garden in November, 1953; the other in a meadow with hawthorn and other scrub in Wytham Wood.

Conclusions

Southern England appears to be the limit of the range of one species, *D. helvetica*. It was caught in the largest numbers in the New Forest, and appears to be confined to Southern and Western England, not occurring in East Anglia, Kent, around Oxford, or on the Western slope of the Mendips around Wells, Somerset, nor has it been recorded by Basden from Scotland. The range of this species (Fig. III-4) corresponds remarkably well to the distribution of the winter daily minimum temperatures (fig. III-16).

The species occurs only in areas where the mean minimum temperature does not go below 37°F. There is no very close correlation between the distribution, and any other

climatological factor, except the mean average saturation deficit for April, 1921 - 1935, and were this the limiting factor, the

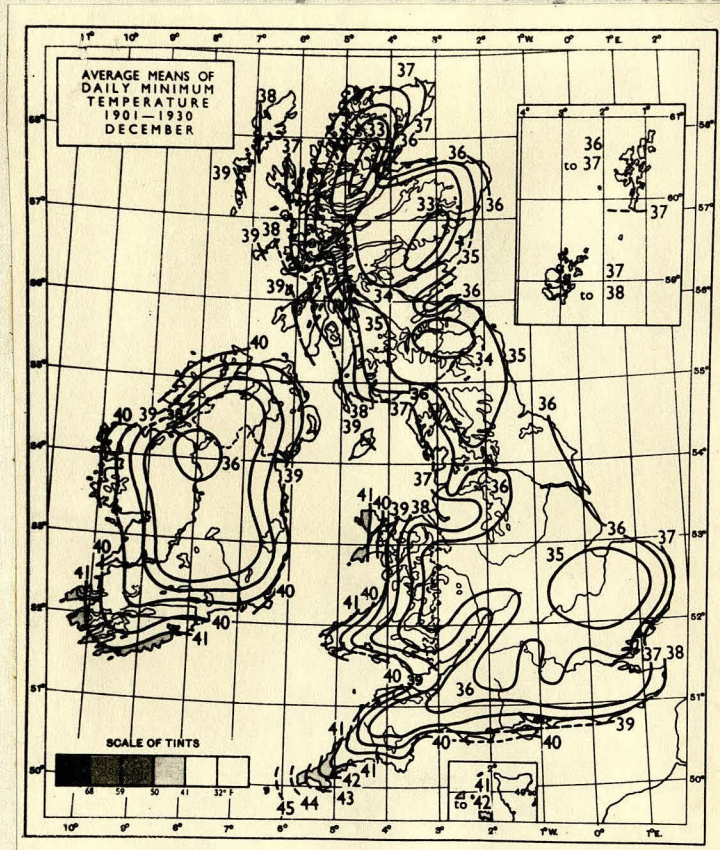


Fig. III-16. The mean average daily minimum temperature for December 1901-1930 (from the Climatological Atlas of the British Isles, 1952)

species should also occur around the coast of Norfolk.

In Switzerland, however, Burla found D. helvetica most common in wood margins in the Voralpen region, occurring up to an elevation of over 1000 meters. The table below shows the mean daily minimum temperature for 10 years, 1943 - 1952, at four of Burla's collecting localities (Annalen der Schweizerischen Meteorologischen Zentralanstalt: 1943 - 1952).

Table III-3

<u>Locality</u>	<u>Altitude</u>	<u>Av. Mean Daily Temp</u>	
		<u>December</u>	<u>January</u>
Altdorf	456 m	31.4°F	29.7°F
Ebnat Kappel	649 m	28.0°F	24.3°F
Binsedeln	914 m	28.2°F	25.7°F
Lugern	745 m	31.0°F	28.5°F

Table III-3. The average mean daily temperature at 7:30 a.m. in December and January, over 10 years, 1943 - 1952

It is clear that D. helvetica in Switzerland occurs in areas where the winter temperatures go well below 37°F, which is apparently the limiting temperature in England. It may be that the Swiss and British strains of the species differ genetically, and are responding very differently to temperature; or it may be that D. helvetica at the edge of its range, in England, is more sensitive to temperature than it is in Switzerland, where the species is more abundant, sometimes even dominant, and presumably the environment is more favourable

to the species. On the other hand, very little is known about the ecology of D. helvetica and it is possible that some factor in the microhabitat limits the distribution of the species. Whatever this factor might be, it seems likely that it is linked in some way with the minimum winter temperatures, since the range of the species corresponds so closely with this climatological factor.

Of the twenty-one other species of British Drosophila in my collections, only eleven were found in numbers sufficient to provide a good idea of their geographical distribution. These eleven species (D. subobscura, D. obscura, D. tristis, D. ambigua, D. Obscura-X, D. phalerata, D. kuntzei, D. melanogaster, D. funebris, D. cameraria, and D. deflexa: Figs. III-5 - III-15) occur throughout Southern England, and their numbers in a particular region are more influenced by habitat than general geographical region. D. histrio and D. vibrissina also appear to have a general distribution; D. busckii was most abundant in Norfolk in late August, 1952; and only a few individuals of the remaining seven species (D. immigrans, D. hydei, D. transversa, D. littoralis, D. forcipata, D. limbata and D. rufifrons) were caught.

HABITAT DISTRIBUTION

The relative frequency of the species of Drosophila varies a great deal with habitat type. Burla (1951: 133-171) has analysed the habitat preferences of the species which occur in Switzerland, using three classes of "Wildbiotopen" (the woodland, wood margin, and isolated groups of trees and hedges) and two classes of "Kulturbiopten" (orchards not near houses, and sites around houses). Hadorn et al. (1952: 142-147) studied the distribution of the species within the "Wildbiopten", making a transect across an open field and into a small woodland. Since most English woodlands are very small, it is difficult to separate the collecting places into woodlands, and wood margins, and I have therefore considered all the woodland and scrub habitats together. A second class of habitats (not discussed in detail by Burla) are open meadows with, at most, a hedge or gorse bushes. My third class of habitats are collecting sites on farms and around houses. The relative frequency of each species for all the collections made in these three types of habitats is given in Table III-4. D. obscura, D. Obscura-X, D. deflexa, D. phalerata, D. kuntzei, D. histrio, D. vibrissina, and D. cameraria are woodland species; D. subobscura occurs with a high frequency in all three types of habitats; D. transversa occurs with a very low frequency in woodlands and in meadows, but not around houses; D. ambigua and D. helvetica occur with a slightly higher frequency around human habitation and in woodlands; and D. melanogaster,

SPECIES	HABITAT		
	I. Woodland and Scrub	II. Open Meadows	III. Farms and near Houses
<i>D. subobscura</i>	54.1%	89.1%	45.1%
<i>D. obscura</i>	21.6%	4.1%	9.3%
<i>D. tristis</i>	4.6%	2.1%	1.2%
<i>D. ambigua</i>	0.4%	0.2%	1.8%
<i>D. Obscura-X</i>	0.8%	---	+
<i>D. helvetica</i>	1.0%	---	2.1%
<i>D. deflexa</i>	5.6%	0.3%	0.6%
<i>D. phalerata</i>	6.3%	0.7%	1.4%
<i>D. kuntzei</i>	2.0%	+	0.1%
<i>D. transversa</i>	0.2%	0.2%	---
<i>D. melanogaster*</i>	0.5%	1.5%	22.3%
<i>D. funebris*</i>	1.1%	1.2%	12.0%
<i>D. busckii*</i>	0.1%	0.3%	3.3%
<i>D. immigrans*</i>	+	---	0.1%
<i>D. hydei*</i>	+	+	0.5%
<i>D. histrio</i>	0.3%	---	+
<i>D. cameraria</i>	1.2%	+	+
<i>D. vibrissina</i>	0.1%	---	---
<i>D. littoralis</i>	+	+	---
<i>D. forcipata</i>	+	---	---
Other <i>Drosophilids</i>	0.1%	0.2%	---
Total No. of Flies	18,536	3,462	4,363
Total No. of Collection Sites	29	15	7

Table III-4. The relative frequency of 20 species of British *Drosophila* in 3 types of habitat. * denotes the species which are cosmopolitan, i.e. reported from many parts of the world.

+ denotes a species frequency of less than 1%.

D. funebris, D. busckii, D. immigrans, and D. hydei (all cosmopolitan species) are closely associated with man. In addition, it is clear from the distribution and percentage catch (fig. III-10) that D. phalerata is more abundant near water than in dry localities. It is clear that the largest number of European species occur in woodland and scrub habitats; in the meadows only D. subobscura is caught in large numbers; on farms and around houses there is a much higher proportion of the cosmopolitan species, which apparently owe their world-wide distribution to the fact that they have become associated with human habitation. These observations agree reasonably well with those of Timoféeff-Ressovsky (1940a), Burla (1951) and Hadorn et al. (1952). However, the English species of Drosophila appear to differ in frequency from those in Switzerland.

Burla (1951: 142-145) discusses the species dominant in Switzerland, i.e. those which are most abundant in a particular collecting place in a given type of habitat. He found the following eleven species dominant in 125 different woodland and wood-margin collecting sites: D. obscura, D. subobscura, D. testacea, D. kuntzei, D. helvetica, D. funebris, D. histrio, D. littoralis, D. alpina, D. melanogaster, and D. hydei. In 41 collections, made in comparable habitats in June, July and early August (when the largest number of different species appear), I found only three dominant species, D. subobscura, D. obscura and D. deflexa; and when all collections made in

woodlands and wood margins are considered, only two other species (D. phalerata and D. transversa) were dominant. The percentage of dominance of the various species for my 41 summer collections made in woodlands and wood margins (as compared with those collections of Burla) is shown in Table III-5.

Table III-5

English collections Swiss collections

D. subobscura	56%	22%
D. obscura	32%	46%
D. deflexa	12%	---
Other species	---	32%

Total no. of collecting sites 41

Table III-5 The percentage of dominance of the various species in English and Swiss woodlands and wood margins. (i.e. that percentage of the total number of collections in which it was dominant).

The smaller number of dominant species, and the greater degree of dominance of D. subobscura, (a species which is extremely widespread, and apparently able to go into unfavorable habitats such as open meadows) is probably an indication that England is on the outer margin of the distribution of the genus, not merely because of its peripheral European position, but also because of the low average temperatures, and lack of large woodlands.

The degree of dominance of D. subobscura varies with the type of habitat. I found a decrease in the relative numbers of D. subobscura as cover increased. This is clearly shown in Table III-5, which gives the relative proportions of species caught in two transect collections, one made near Wells (Somerset) on July 22-24, 1952; the other made on Dartmoor (Devon) on August 4 and 5, 1952. The collections in the four localities in Somerset were made at approximately the same times, and the larger numbers of flies caught in the woodland is almost certainly an indication of greater population density of Drosophila in the woodland than in the open meadow. Thus, although D. subobscura has the highest relative frequency in the open grassland, the absolute numbers of flies in the woodland may be higher.

Not only is there a clear difference between the Drosophila fauna of different types of habitats, but even in different woodlands there are variations in the relative numbers of the various species. This is shown by collections made in 7 woodlands in the New Forest between June 14 and June 22 (Table III-7). The same variation in species frequency between different woodland habitats was apparent in Bagley Woods, Berkshire (where monthly collections were made on the same days); in A and B localities of Wytham Woods, Berkshire; and at Salcombe, Devon; and in East Anglia (Appendix I). Even collections in different areas within a woodland may differ significantly (Table III-8). I have not found it possible to associate particular species of

SPECIESLOCALITIES

	A. SOMERSET				B. DEVON			
	1.	2.	3.	4.	1.	2.	3.	4.
subobscura	99%	100%	68.1%	50.6%	96.5%	97.0%	83.6%	63.9%
obscura	-	-	23.5%	31.0%	2.1%	2.6%	13.5%	20.2%
tristis	-	-	6.9%	7.1%	0.7%	0.2%	2.3%	6.9%
ambigua	-	-	1.2%	1.2%	-	-	0.7%	0.2%
Obscura-X	-	-	0.2%	1.5%	-	-	-	-
deflexa	-	-	2.5%	2.9%	0.7%	-	-	-
phalerata	-	-	1.2%	2.0%	-	-	0.2%	3.8%
funebria	-	-	0.2%	2.0%	-	-	0.2%	0.7%
cameraria	-	-	2.4%	1.8%	-	0.2%	-	4.4%
vibrissina	-	-	-	0.9%	-	-	-	-
other Dro- sophilids	1.0%	-	0.3%	-	-	-	-	-
Total No	210	270	597	1076	141	338	429	550

Table III-6. Transect collections showing the decrease in proportion of D. subobscura with increase in cover. The localities are as follows:

A. Somerset

1. Open grassland on top of a hill grazed by sheep, with grass, trefoil, thyme, clover, heather, and occasionally gorse and blackberry.
2. Same grassland as above, with more gorse.
3. Small open deciduous copse with sycamore, alder, oak, and waist-high grass.
4. Dense coniferous copse with spruce, and a few oak. Some grass on the ground grazed by cows, but mostly bare and dry.

B. Devon

1. Open moor on hillside with heather, ling, juncus, sphagnum, and grasses.
2. Open moor (further down hillside toward the stream) with dense bracken cover.
3. Fast-running stream with mossy rocks, and grassy banks with some bracken, ash, rowan, and other bushes.
4. Same stream running through small wood with large pines, oak, spruce, fir, larch, juniper, ash, and rhododendron.

	1.	2.	3.	4.	5.	6.	7.
subobscura	27.4%	49.1%	80.0%	74.0%	39.0%	31.5%	29.4%
obscura	55.0%	34.0%	17.3%	21.4%	36.2%	31.9%	18.1%
tristis	1.6%	2.8%	1.4%	0.7%	---	0.4%	0.7%
ambigua	---	0.3%	---	---	---	---	2.5%
Obscura-X	10.6%	0.3%	0.5%	0.3%	0.5%	1.3%	0.5%
helvetica	1.6%	7.2%	---	---	2.5%	1.7%	20.8%
deflexa	2.0%	0.8%	---	0.5%	---	---	0.2%
phalerata	---	1.4%	0.5%	0.7%	9.6%	8.8%	7.4%
kuntzei	1.6%	1.4%	---	---	8.3%	18.5%	16.9%
funebri	---	---	---	---	---	---	2.7%
histrion	0.4%	2.5%	0.5%	1.3%	2.4%	5.0%	0.5%
vibrissina	---	---	---	---	---	0.8%	---
Total No. of flies	255	362	214	308	218	238	403

Table III-8. The relative frequency of different species of Drosophila in seven woodland habitats in the New Forest, Hampshire.

1. Old oak forest (trees up to 2' in diameter) with holly and some beech between heath and houses; quite shady. Two ponds; very little ground cover.
2. Very large oaks and beeches (up to 5' in diameter); quite shady. Bracken and grass ground cover; no water; no houses near, but picnickers frequent.
3. Plantation of large pines evenly spaced, open and sunny; bracken undergrowth dense and waist high; dry.
4. Plantation of large pines, small pines, and oaks; quite shady; bracken and heather undergrowth not dense; quite dry.
5. Saplings of oak, alder, and beech along running stream; no boggy banks; shady and well-protected.
6. 20-year-old spruce plantation near stream; very shady; bracken and moss ground cover.
7. Grove of large beeches, and some oaks with holly near meadow and bog; quite shady; dry leaves covering ground.

Drosophila with a particular kind of vegetation. For example, in Wytham Woods, Berks, in July, 1952, there was a much higher frequency of D.deflexa in a sycamore (fig. IV -5A) wood than in a fir wood (fig. IV- 5B), whereas in Bagley Wood, Berks, in July 1953, there was a higher frequency of D.deflexa in a fir wood (fig. III-21) than in a sycamore wood (fig. III-19). It seems likely that factors such as moisture, or the presence or absence of cow dung or garbage are more important than the presence of a particular kind of plant. (This is not true of all species of Drosophila. Blight and Romano (1953) found D. americana associated with willows, and found that this species breeds in cracks in the bark of these trees.)

DAY TO DAY VARIATION

It has been shown above that species frequencies vary with habitat. Even in the same woodland, however, the species frequency varies significantly from day to day. All-day collections show this most convincingly, because in such cases large numbers of flies were caught, the cups were hung at identical sites, and the times of collection were most comparable. Four pairs of collections made in the same localities are shown in Table III-8. (The first collection was made only a few days before the second in each pair.) The difference in percentage between these pairs is significant at the 1% level in all cases.

Table III-8

	Wytham A		Wytham B		Scoulton A		Scoulton B	
	July 17	July 19	July 17	July 19	Aug. 24	Aug. 31	Aug. 24	Aug. 31
subobscura	25.4	20.3	57.2	50.8	57.5	51.1	55.8	51.2
obscura	42.9	30.6	25.1	26.3	9.7	9.8	13.8	11.9
tristis	2.1	6.0	0.8	2.8	15.0	15.5	16.2	10.9
afflexa	26.9	35.6	11.2	10.5	1.5	9.5	1.8	5.4
pallida	--	--	3.9	6.3	0.8	1.3	2.2	5.4
others	2.7	7.5	1.8	3.3	15.5	12.8	10.2	15.3

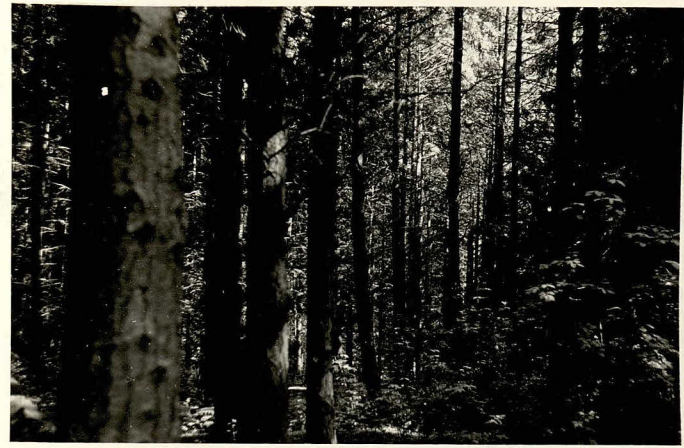
Table III-8. The species frequency during all day collections made in 1952.

These figures strongly suggest that weather affects the relative frequency of flies caught in a particular locality. The details of these collections and collecting places are given in Chapter IV, and in appendix II.

It can also be seen from Table III-8 that the difference

between the Scoulton collections in the same locality on different days is greater than the difference between the two Scoulton collections made on the same day. This is because Scoulton A and Scoulton B are different areas within the same mixed deciduous-coniferous woodland, and the vegetation in both areas is very similar. The same is not true for the Wytham localities which, though near to each other, are very different types of woodlands. (Wytham A is a sycamore wood; Wytham B is a fir plantation). In fact, the difference in relative frequency in unlike woodlands on the same day (Wytham A and B) is clearly much greater than the daily variation in the species frequency or the variation within a single type of woodland on the same day.

Fig. III-17. The six localities in Bagley Wood where monthly collections were made.



A. A dark spruce wood (Bagley I)



B. A plantation of young spruce trees.
(Bagley II)



C. A sycamore wood with under-
growth of ash (Bagley III)



D. A mixed wood of ash, sycamore,
oak, pine, and larch, with
ash undergrowth (Bagley IV)



E. A dark fir plantation (Bagley V)

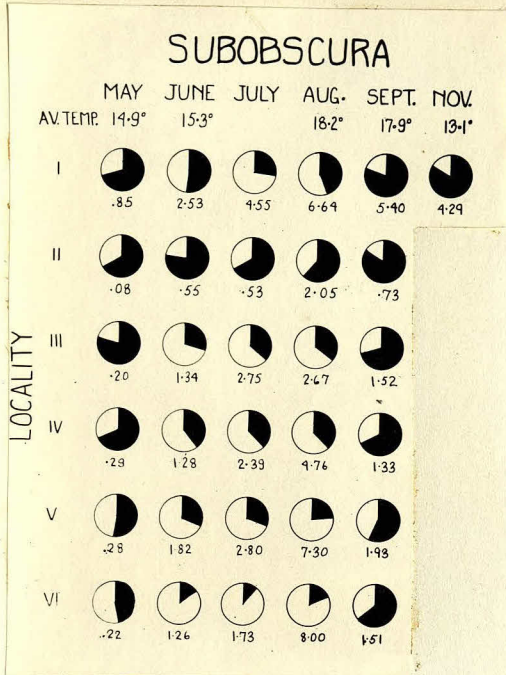


F. A mixed woodland of oak, with some
hawthorn, and ash (Bagley VI)

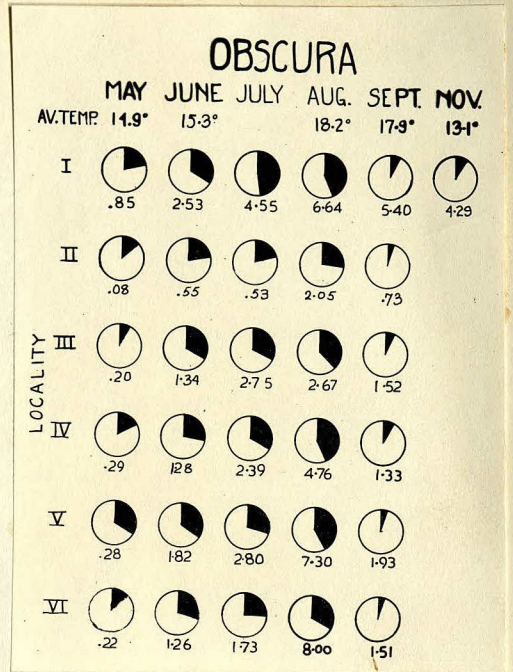
SEASONAL VARIATION

In considering the geographical distribution of Drosophila in England, it is difficult to evaluate to what extent the varying species-frequencies are due to seasonal variations in the different species caught, and to what extent they represent true geographical differences. In an attempt to clarify the problem, monthly collections were made (from May until September) in six woodland localities in Bagley Wood, Berks (fig. III-17); and in two Oxford gardens.

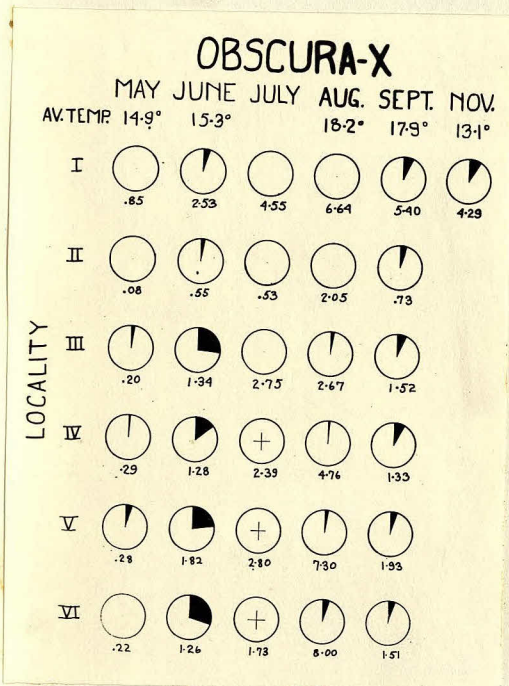
In the woodlands, there is a clear increase in the relative proportions of species other than D.subobscura in the spring; and a decrease in the autumn (fig. III-18). The average number of flies (all species) caught per cup per collection increased in the spring and decreased in the autumn, indicating an increase in the activity and/or size of the Drosophila population. Thus, the total numbers of D.subobscura in a woodland increase, even though the relative frequency falls (fig. III-18A). The other species almost certainly increase in numbers during the summer. D.obscura (fig. III-18B) is most abundant during the months of June, July and August, but is caught in much smaller numbers in May and September. D.Obscura-X (fig. III-18C) seems to be most abundant in June and September, and decreases in frequency during July and August. D.deflexa, on the other hand, has a marked peak of abundance in July (fig. III-18D). The



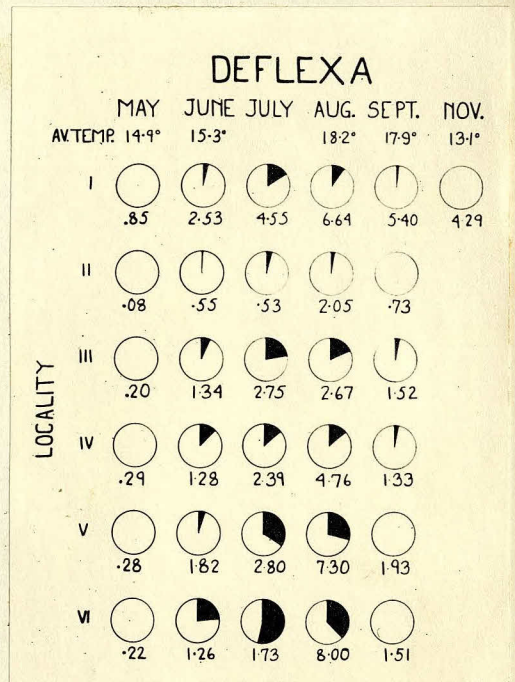
A.



B.



C.



D.

Fig. III-18. Changes in species frequency at six localities in Bagley Woods, Berks (illustrated in fig. III-17). The shaded area of the circle represents the frequency of the species, expressed as a percentage of the total catch at that locality.* The numbers below the circle indicate the average number of flies (of all species) caught per cup per collection. * + indicates a frequency of less than 1%.

The other species (D. tristis, D. phalerata, D. kuntzei, D. transversa, D. cameraria, D. melanogaster, and D. funebris) were all caught at frequencies of less than 10%, and showed no obvious variation with season (appendix I).

SPECIES	MONTH						
	May	June	July	Aug.	Sept.	Oct.	Nov.
subobscura	100%	95.2%	89.9%	67.5%	59.3%	75.5%	87.0%
obscura	-	-	3.4%	14.7%	15.1%	-	-
ambigua	-	-	1.7%	0.6%	2.6%	0.7%	-
melanogaster	-	4.8%	1.7%	11.7%	19.3%	15.9%	-
funebris	-	-	0.6%	2.5%	2.2%	4.6%	-
busckii	-	-	-	-	0.4%	-	-
hydei	-	-	-	-	-	2.0%	6.5%
other species	-	-	3.9%	1.2%	0.9%	2.0%	3.9%
Total No. of flies	4	146	179	165	228	151	77

Table III-9. Monthly collections made in a small garden in a housing estate along Southern Bypass, Oxford.

SPECIES	MONTH				
	May	June	July	Aug.	Sept.
subobscura	90.2%	93.8%	53.7%	79.2%	74.6%
obscura	2.7%	2.6%	3.6%	3.6%	6.6%
ambigua	2.7%	0.7%	2.4%	-	4.9%
melanogaster	-	2.0%	39.0%	9.7%	8.3%
funebris	0.5%	0.7%	0.5%	-	0.8%
hydei	-	-	-	4.1%	0.8%
immigrans	0.5%	-	-	-	-
other species	3.2%	0.3%	-	3.5%	4.0%
Total No. of flies	183	305	205	197	122

Table III-10. Monthly collections made in a large garden adjoining a field in North Oxford.

Collections in gardens also showed a decrease in the relative abundance of D.subobscura during the summer, and an increase in the autumn (Tab. III-9 and III-10). The reduction was, in this case, due to the summer increase in the percentage of the cosmopolitan species, particularly D.melanogaster. In Oxford, this species was most abundant in one locality (Tab. III-9) in July, and in the other (Tab. III-10) in August, September and October. (The greatest abundance of D.melanogaster in September and October was also reported for Switzerland by Burla.)

Thus, it can be seen that the low frequency of D.obscura and D.deflexa in East Anglia is probably due to the fact that collections were made in May and late August; and the irregular distribution of D.Obscura-X may well be because this species is not very common in July and August, when most of the collections were made.

SUMMARY

Although the collecting method does not, for reasons given above, make it possible to estimate the true relative frequency of various species of Drosophila in England, non-the-less, it is possible to gain a great deal of information about distribution. As far as can be determined from the numbers collected, all the European species, except one, are general in their distribution in England, and their frequencies are more influenced by habitat than by general geographical area.

The one exception, D. helvetica, has a range which corresponds very closely to the areas of milder winters. One of the cosmopolitan species, D. busckii, was caught in large numbers only in Norfolk, but the others seem to be general in their distribution.

The species frequencies are influenced by many factors. They do vary from day to day, and with time of day; but even greater differences than these are shown between collections in different types of habitats, and at different times of year in the same locality.

There are a smaller number of dominant species of Drosophila in England as compared with Switzerland, while D. subobscura, which of all the 'wild' species seems to have the widest range of habitat tolerance, is the dominant species in England (when collections are made with fruit bait). These facts, together with the relatively high proportion of cosmopolitan species¹, would seem to indicate that England is on the outer margin of the distribution of the genus.

1. In the world distribution of Drosophila, over 90% of the species found in any zoogeographical region are endemic to that region; of the species found in England, only 65% are confined to the palaearctic region.

CHAPTER IVDIURNAL PERIODICITY OF DROSOPHILA

A marked diurnal periodicity has been noted for several species of Drosophila by Timofeef-Ressovsky (1940a), Dobzhansky and Epling (1944), Burla (1951) and Hadorn et al. (1952). Timofeef-Ressovsky found a morning and evening peak in activity (measured as a number of flies caught in baited bottles), the morning peak about 9:00 a.m., the evening peak about 9:00 p.m. Though some flies were caught at all periods throughout the day and night, there was a marked decrease in activity at mid-day and at night.

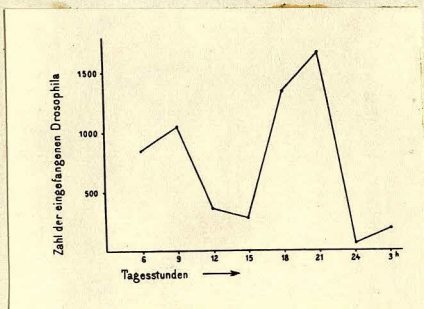


Fig. IV-1. Timofeef-Ressovsky (1940a). The total number of Drosophila in one collecting experiment which was repeated every three hours.

This work is difficult to evaluate, since no exact description is given of the collecting technique, either in the above paper, or in any other I could find (1938, 1939, 1940b, 1940c), nor is any indication given of the time of

year, or the meteorological conditions at the time of the 24-hour collection. It is difficult to explain the flies caught at 12:00 midnight (unless traps from which the flies could not escape were used, and the flies caught shortly after 9:00 were retained until they were removed at midnight) because other authors (Dobzhansky and Epling, 1944; Burla, 1951; Hadorn et al., 1952) have all noted that Drosophila cease flying when it gets

dark, a fact which my observations confirm. The increase in activity at 3:00 a.m. (fig. IV-1) does not agree with my observations, unless the collections were made in June, when it is already getting light at that time. Since the activity of all species collected is lumped in one graph, by Timofeef-Ressovsky, it is impossible to tell if the discrepancy between his observations and mine is due to the fact that different species were studied.

Dobzhansky and Epling (1944) have made a detailed study of D. pseudoobscura in California. (There appears to have been no attempt to distinguish between D. pseudoobscura and D. persimilis, which are virtually impossible to tell apart except by breeding.) They also refer to morning and evening peaks of activity (fig. IV-2), and come to the conclusion that light is the most important factor in determining this pattern of activity.

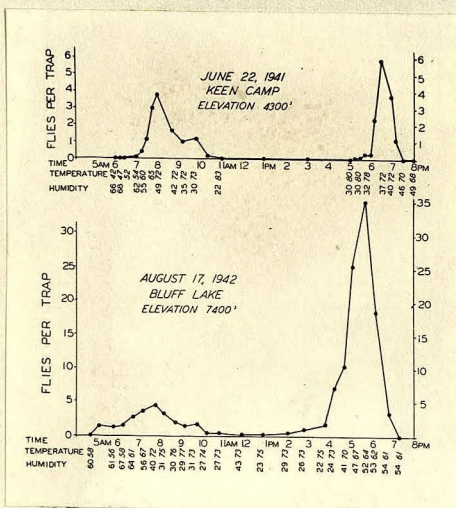


Fig. IV-2. Dobzhansky and Epling (1943:26). The diurnal periodicity in the activity of Drosophila pseudoobscura.

This conclusion is based mainly on the fact that "the maxima as well as the arrival and disappearance of flies tends to come at the same time of day despite differences in elevation, temperature, humidity and environment generally." (1943:38)

They also note, firstly, that "a temperature of about 50°F (10°C) is apparently limiting

for D. pseudoobscura", since only one fly was caught below that temperature and "laboratory-grown flies fell almost immediately into the diurnal cycle characteristic of the wild flies in the same locality". The one fact they find inconsistent with their hypothesis of light as the prime environment factor is that "more time elapses between sunrise and the morning maximum of abundance of flies than between the afternoon maximum and sunset" and they conclude that "the reacting material, the fly, is evidently not the same at different times of day."

Commensurate with the difficulty of analysing causal factors from observation rather than experiment - a difficulty noted by Dobzhansky and Epling - is the difficulty of eliminating the subjective selection of data in arriving at conclusions. Thus, the assertion that "the diurnal periodicity is determined by changes in light intensity during the day" (Dobzhansky and Epling, 1943: 44) is based on a great deal of observation which is discussed in detail: yet no measurements of light were made at the collecting sites. Furthermore, were the flies to react differently at different times of day (as Dobzhansky states), analysis of behavior would be extremely difficult since time of day as well as light would be important in determining the pattern of diurnal periodicity. My observations of the British members of the obscura group indicate that the low morning temperatures, not "a difference in the reacting material", cause the lower and later morning maxima (page 148).

Pavan, Dobzhansky and Burla (1950:36-43) found that the Drosophila in the Brazilian rain forest, at least on cloudy days, do not have peaks of activity, but rather there is an increase in the activity of flies during the morning which reaches a 'plateau' during the day and declines toward sunset. They were not able to determine the nature of the stimuli which produce the diurnal behavior, but suggest that relative humidity may be more important than it is in the case of D.pseudoobscura. No measurements of light were made, although humidity and temperature were recorded. My observations show that D.obscura often has the same type of activity pattern described above, yet is responding to changes in light, at least in the morning and evening. Until there is more data, it is difficult to be certain if the Brazilian flies are, in fact, responding to humidity.

Mitchell and Epling (1951: 696-708) did further studies of the diurnal periodicity of D.pseudoobscura, and confirm, using a light meter, the earlier observations that this species is responding primarily to light. They contrast the behavior of D.pseudoobscura, which responds to light, with that of Brazilian species. The activity of the latter, they state, "is apparently correlated with relative humidity", and therefore "the cycles are less definite than in D.pseudoobscura." This is a dangerous extension of the statement made by Pavan, Dobzhansky, and Burla, and is neither warranted by the data presented by those authors, nor the conclusions which they draw from it.

Burla (1951:30) mentions in passing that he noted the same dependence of activity on light intensity as found by

Dobzhansky for D. pseudoobscura, but does not say how he determined this dependence. Hadorn et al. (1952: 138-42) discuss the periodicity of several different species of Drosophila. They conclude that light is the determining factor in the activity of D. subobscura since maxima appear at times of lower light (morning and evening) and since the flies appear 1-2 hours later, and disappear earlier, in the woods than in the field. Although temperature measurements are given, once again, no measurements of light were made. (Fig. IV-3 and IV-4).

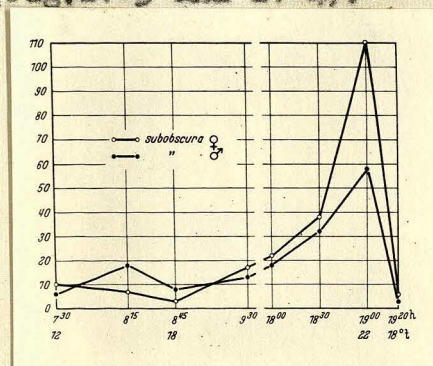


Fig. IV-3. Proportion of the two sexes of D. subobscura during a collection at Viseu, Portugal.

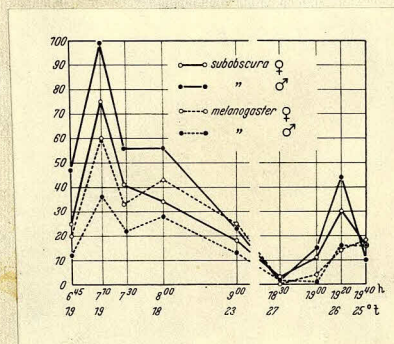


Fig. IV-4. Proportion of sexes of D. melanogaster and D. subobscura during a collection at Berdun, Spain.

Despite the obvious importance of light in the flight of Drosophila, the hypothesis that "the diurnal periodicity is determined by changes in light intensity during the day" did not seem to explain adequately all the observations made by the above authors. To investigate the conclusions of Dobzhansky and Epling, and Hadorn et al., and to compare the activity of the European members of the obscura group with that of related species from California and Southern Europe,



Fig. IV-5A. A sycamore grove in Wytham Woods, Berks. The photograph was taken in May before the canopy was fully out.



Fig. IV-5B. A fir grove in Wytham Woods, Berks.



Fig. IV-5C. An open meadow in Wytham Woods, Berks.

I made numerous all-day and evening collections in 5 localities (3 in Wytham Woods, Berks.: 2 near Scoulton, Norfolk).

For the all-day collections, baited cups were set out the previous evening, and a collection was made every $1\frac{1}{2}$ to 2 hours from dawn until dusk. Readings of temperature, light, humidity (and in some cases, wind) were taken at the time of each collection in the same place (usually the center) within the collecting area. The flies from each collection were kept separately and identified in the laboratory the next day. Activity was measured by the number of flies caught per 10 cups, temperature by a Centigrade thermometer, humidity with a sling psychrometer, light with a Weston light meter (reading against a white plastic card), and wind by an airmeter¹. There was considerable variation, especially in light, over the collecting area, but I only recorded the variation found within approximately a meter radius of the observation place. Employment of the above methods makes results comparable to those of Dobzhansky and Epling, who define the activity they studied as "flight in search of food which leads flies to enter traps" (1943: 27).

Only two of the six species of the obscura group found in England, namely D. subsobscura and D. obscura, were obtained in numbers sufficient for careful analysis of the factors influencing their activity. The manner of presentation of the

1. Kindly lent by the Meteorological Office of the Air Ministry.

data was suggested by Dr. D.J.Finney as a way of eliminating as much as possible subjective opinion from the analysis of the data. Dr. M.R.Sampford has analysed the regressions of temperature, humidity, and light against the number of flies caught during evening woodland collection of D.subobscura and D.obscura. The results of these analyses will be discussed on pages 145-147 and 155 .

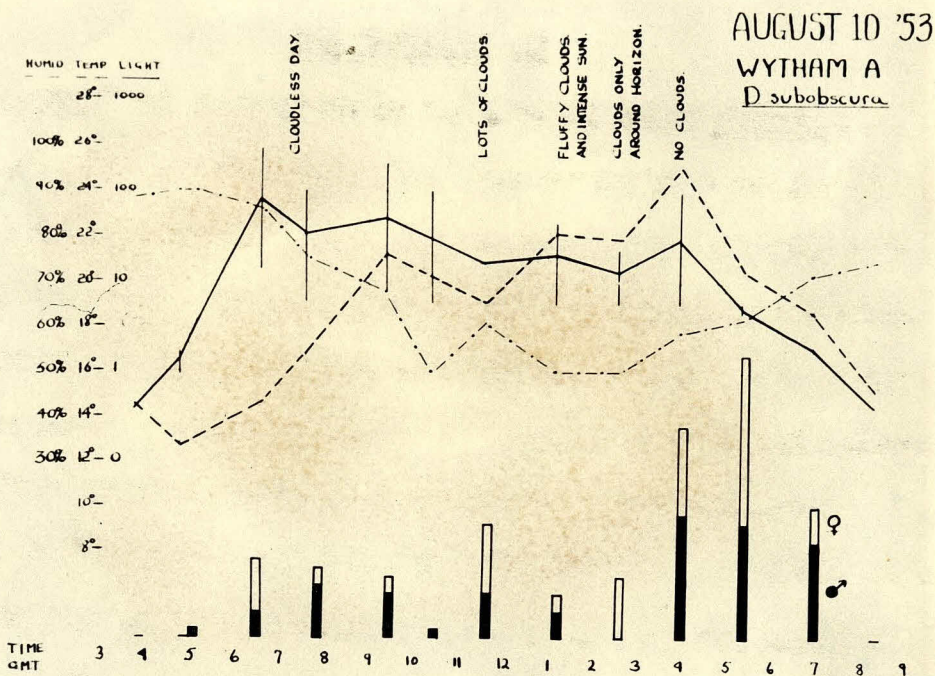


Fig. IV-6. All-day collection in a dense woodland showing temperature, humidity, light, and number of D. subobscura caught. Light is indicated by —, temperature by - - and humidity by - · - ·.

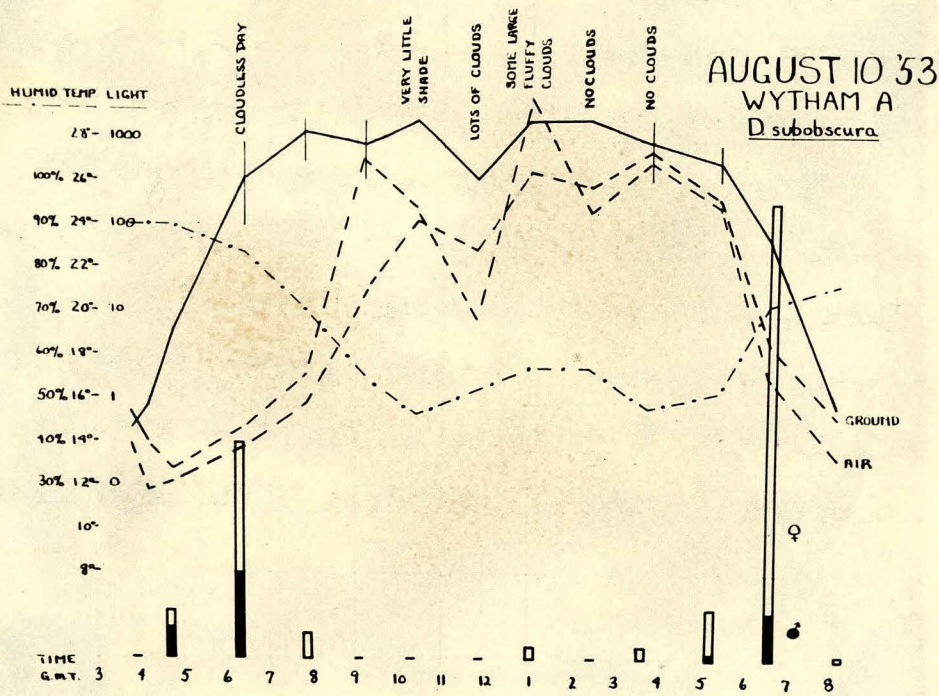


Fig. IV-7. All-day collection in a meadow showing temperature, humidity, light and number of D. subobscura caught. Light is indicated by —, temperature by - - and humidity by - · - ·.

D. SUBOBSCURA

D. subobscura is widely distributed in England, occurring both in dense woodlands and open meadows (p); and although the overall pattern of activity in these different habitats is similar, it differs in detail. Three patterns of activity can be distinguished. The total collection data are in appendix II. A few examples have been chosen to illustrate the discussions.

Fig. IV-6 shows a typical all-day summer collection in a dense woodland habitat, Wytham A (fig. IV-5A). This is a plantation of Acer pseudoplatanus, with a closed canopy and very low light. The activity of the flies commences at dawn, is fairly uniform throughout the day, reaches a peak in the evening, and ceases at dusk. This pattern of activity was shown on each occasion when an all-day collection was made in this locality (July 17 and 19, 1952; August 10, 1953), and also during one all-day collection made on an overcast day in a fir plantation (Wytham B: fig. IV-5B).

A second variant of activity pattern, very similar to that found by Dobzhansky and Epling for D. pseudoobscura at Keen Camp, California, was found in an open meadow (Wytham C: fig. IV-5C). In this case, activity begins at dawn, there is an early morning peak, a complete cessation of flight at mid-day, an abrupt peak in the evening, and a sharp drop in activity at dusk (fig. IV-7).

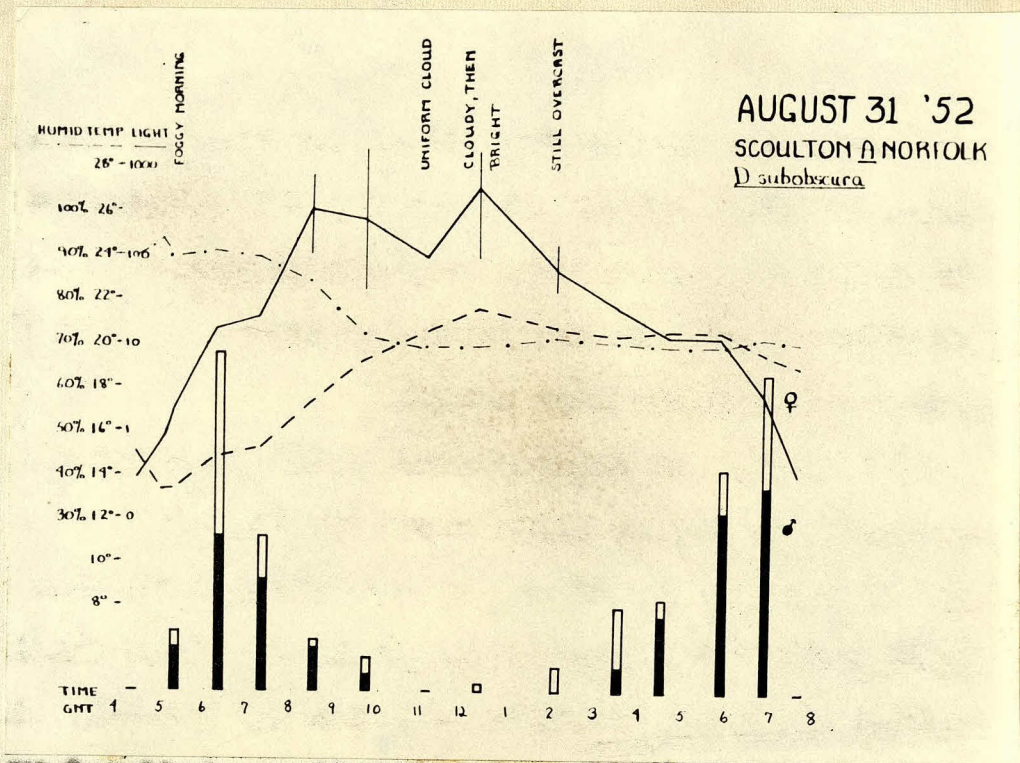


Fig. IV-8. All-day collection in open woodland showing temperature, humidity, light and number of D. subobscura caught. Light is indicated by — · — ·, temperature by — — and humidity by - - - -.

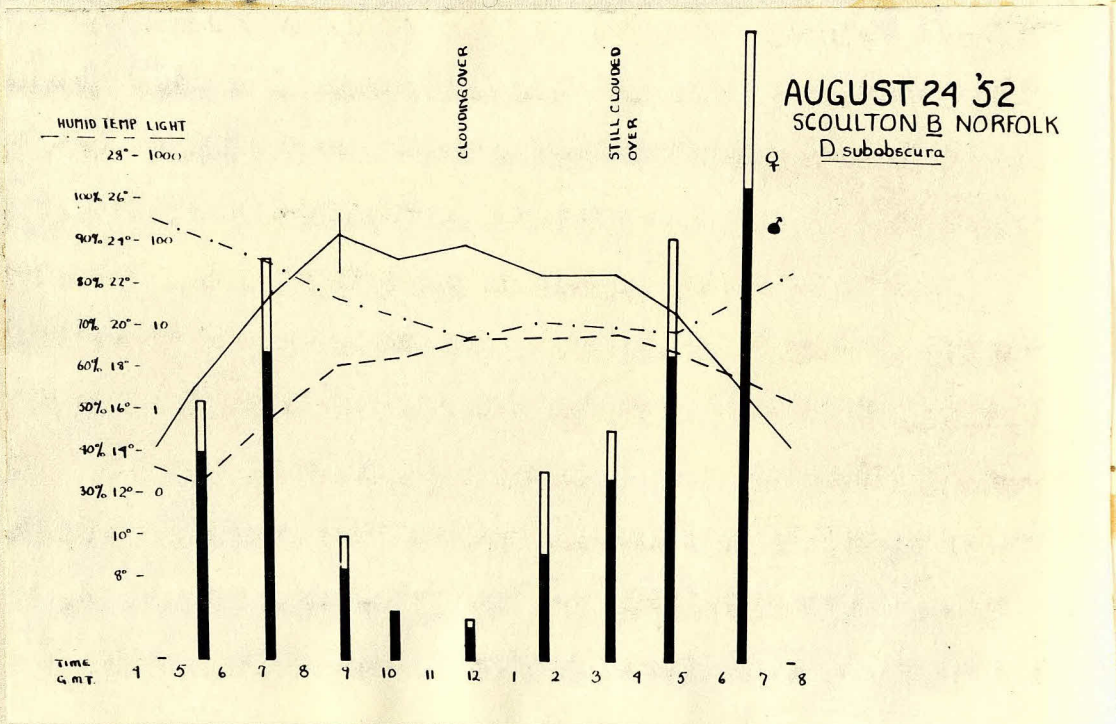


Fig. IV-9. All-day collection in an open woodland showing temperature, humidity, light and number of D. subobscura caught. Light is indicated by — · — ·, temperature by — — and humidity by - - - -.

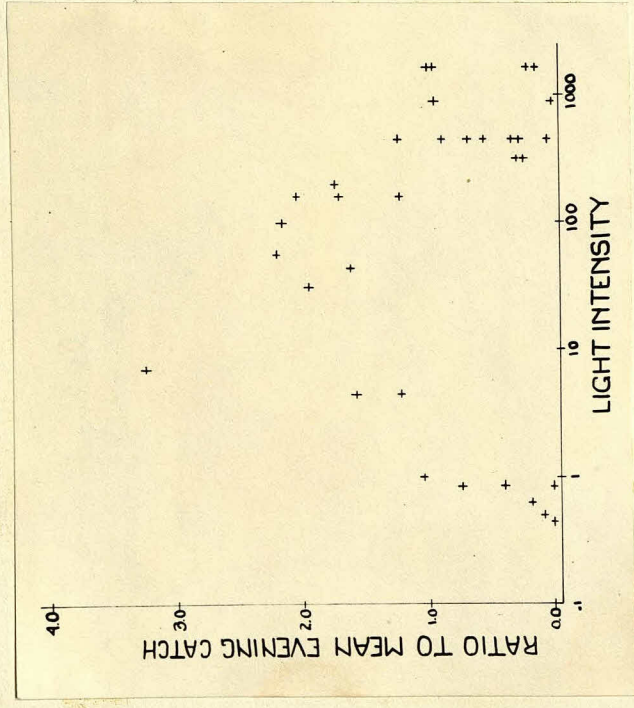
Only one all-day collection was made in the open meadow, but four out of five evening collections made in this locality show the same very abrupt peak of activity just before dusk. On the fifth day it rained, and the peak was much earlier and less abrupt.

A third, and intermediate, pattern of activity occurs in open woodlands and is illustrated by figures IV-8 and IV-9. There is a beginning of activity at dawn, a morning peak, a smaller number of flies caught at mid-day (but usually not a complete cessation of activity), another (usually higher) evening peak, followed by complete cessation of flight at dusk. This pattern of activity was found in six collections made in May and August, 1952, in a mixed deciduous-coniferous woodland (near Scoulton, Norfolk: the trees are of a very unequal height, and there is no real canopy), and in one collection made on a bright day in the fir plantation (Wytham B, July 19, 1952).

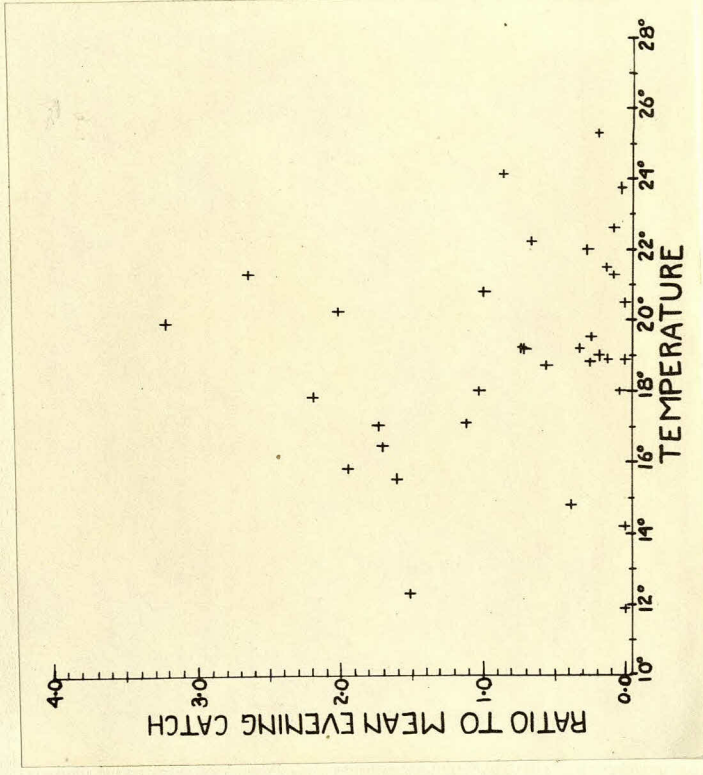
The activity cycle of D. subobscura is, therefore, clearly divisible into five phases: the commencement of activity in the morning, the morning peak, the mid-day drop in activity, the evening peak, and the evening cessation of flight. To obtain further data on the evening peak, five evening collections were made at A and C localities, Wytham (beginning at about 2:00 p.m. and continuing until activity stopped in the evening).

FIG. IV-10
EVENING ACTIVITY OF *D. SUBOBSCURA* IN MEADOW

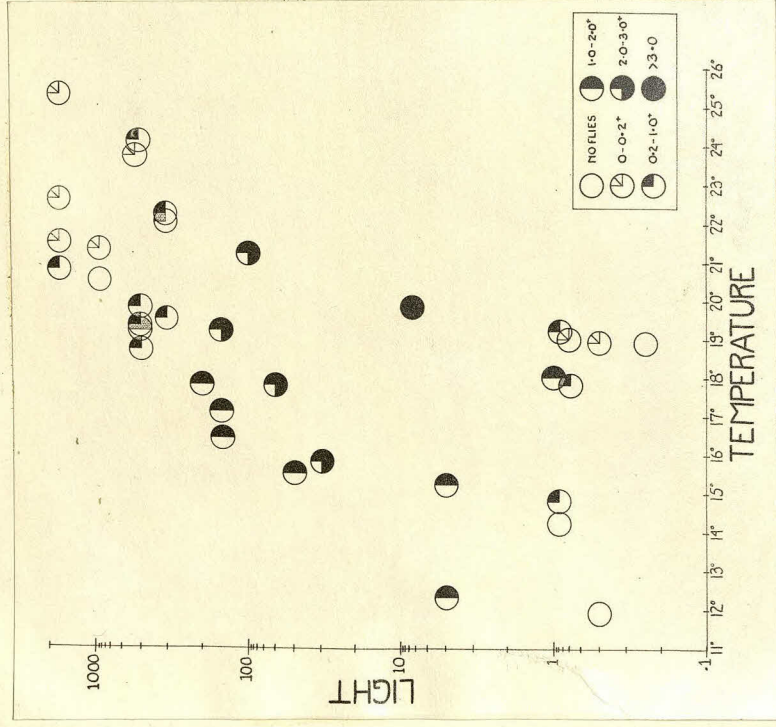
The activity (measured as the ratio of the size of a particular catch to the average size of collections made that day between 2:00 p.m. and 7:15 p.m.) in relation to light, temperature, and humidity. The points represent evening collections made at Wytham C on July 10, 29 and 30; and August 5 and 6, 1953.



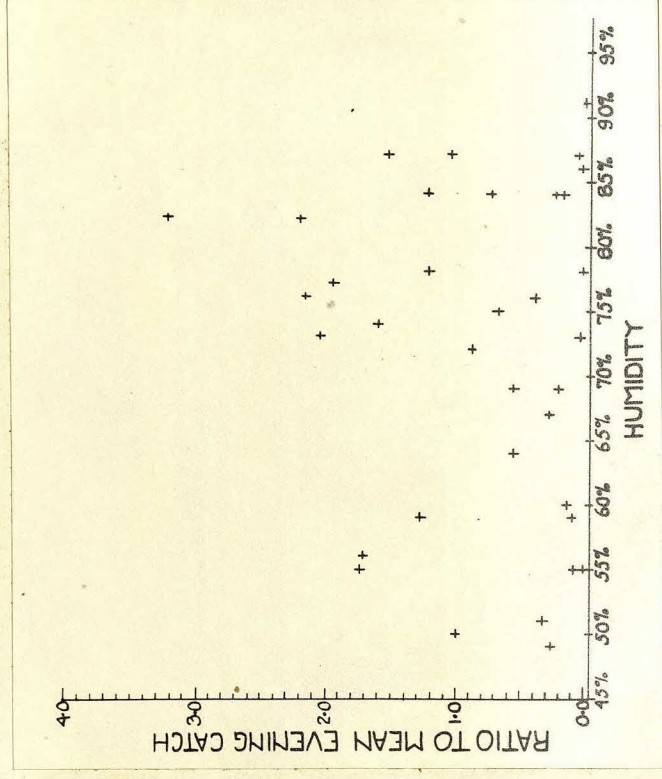
A. Activity in relation to maximum light (measured in candles/lt² and plotted on a log scale).



B. Activity in relation to air temperature (measured in degrees centigrade).



C. Activity in relation to temperature and light (position of circles on graph represents temperature and light at time of collection; shaded area indicates activity).



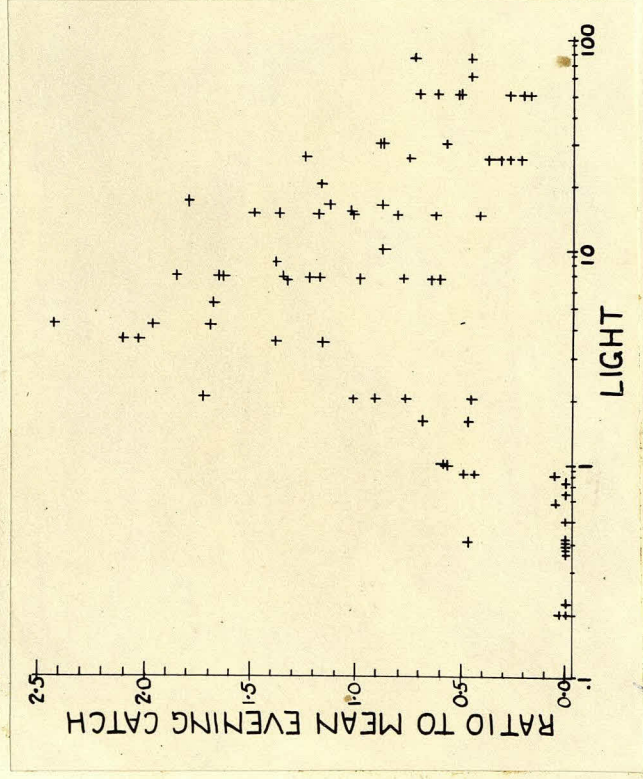
D. Activity in relation to humidity.

Figures IV-10 and IV-11 are summaries of these collections. There is obviously a very high correlation between light and activity. It was thought to be desirable to investigate if temperature had an effect apart from that due to the high correlation with light. The complete curve over the whole range of light has a complicated form, and in order to get an adequate fit, a polynomial of degree 3 or 4 would be required. It therefore seemed better to divide the data into two series, at a light intensity of 6.5 c/ft^2 , and to calculate the linear regressions on light and temperature for the two series separately. Preliminary analysis of the whole series, coupled with results of laboratory experiments, indicated that humidity could safely be ignored in the analysis.

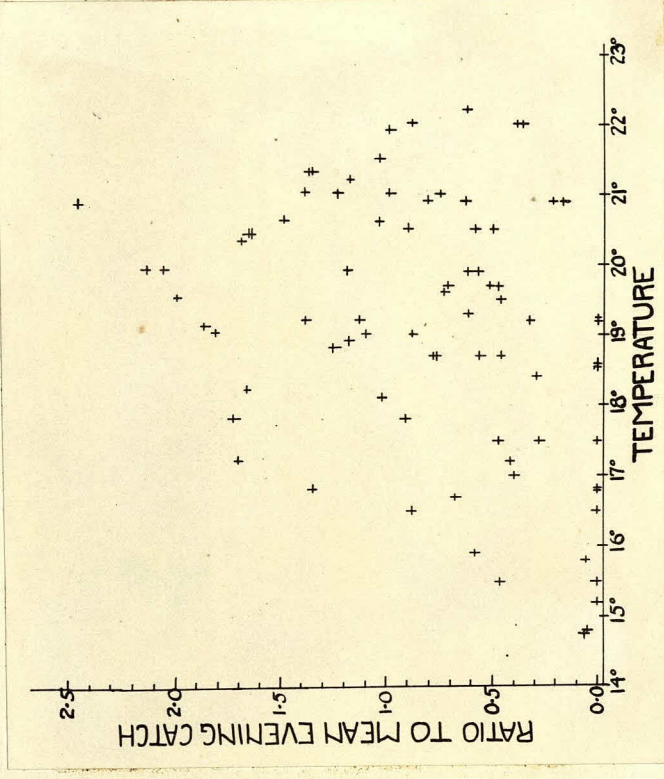
Fig. IV-10A, a summary of all the meadow evening collections, shows a strong correlation between light and activity; the activity is slow as long as the light is about 1000 c/ft^2 , increases when the light drops, reaches a maximum at a light of about 6.5 c/ft^2 , and drops sharply, ceasing when the light falls below 0.8 c/ft^6 . The regression of light (both above and below 6.5 c/ft^2) with number of flies caught is significant at the 0.1% level. The regression of temperature is significant at the 5% level, but after the effect of light has been removed, there is no residual effect of temperature. Thus, the tendency for a decrease in activity above temperatures of 22°C and below 15°C (fig. IV-10B) may be due to the effect of light.

FIG. IV-11
EVENING ACTIVITY OF D. SUBOBSCURA IN WOODLAND

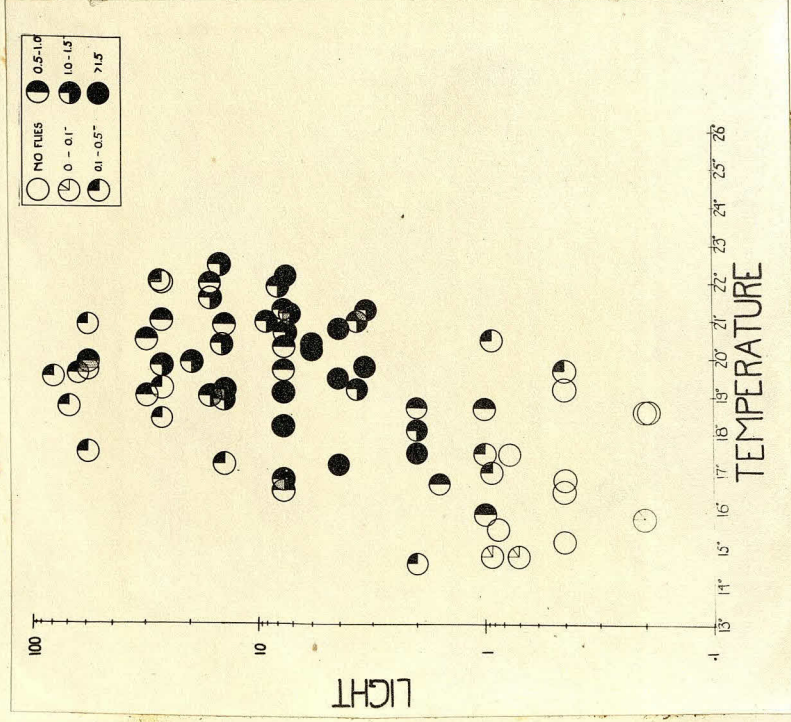
The activity (measured as the ratio of the size of a particular catch to the average size of collection made that day between 2:00 p.m. and 7:15 p.m.) in relation to light, temperature, and humidity. The points represent the afternoon collections made at Scoulton, Norfolk, August 24 and 31, 1952; Wytham A and B, Berks, July 17 and 19, 1952, and Wytham A, July 10, 29, 30 and August 5, 6 and 10, 1953.



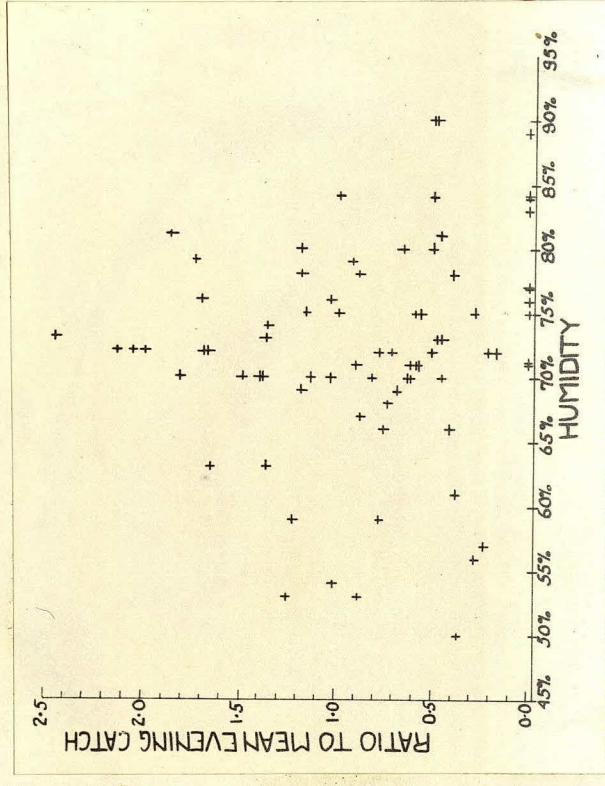
A. Activity in relation to maximum light (measured in candles/lt² and plotted on a log scale).



B. Activity in relation to temperature (measured in degrees centigrade).



C. Activity in relation to temperature and light (position of circles on graph represents temperature and light at the time of collection; shaded area indicates activity).



D. Activity in relation to humidity.

Fig. IV-11 summarises the results of 14 afternoon woodland collections made in Wytham Woods and Scoulton during the summers of 1952 and 1953. The peak of activity is, again, clearly at a light of about 6.5 c/ft^2 , falling off with higher and lower light intensities, and ceasing when the light falls below 0.6 c/ft^2 (fig. IV-11A). As in the open meadow, the regression with light is significant at the 0.1% level. And temperature again shows no residual effect after light is taken into consideration. However, there may be some indication of a drop in activity below 15°C and above 22°C (fig. IV-11B). It is clear (fig. IV-11C) that the maxima fall within a narrow range of light ($2 - 6.5 \text{ c/ft}^2$)², but a much wider range of temperature (17°C to 22°C , or almost the whole range of temperatures encountered). Since both the open and closed woodlands are included in this diagram, the overriding importance of light is less strikingly shown than if only the closed woodlands were included. (Light decreases at a more rapid rate in the open woodlands, so that the peaks of activity are more abrupt, and the time of collection may not be at the true optimum light.)

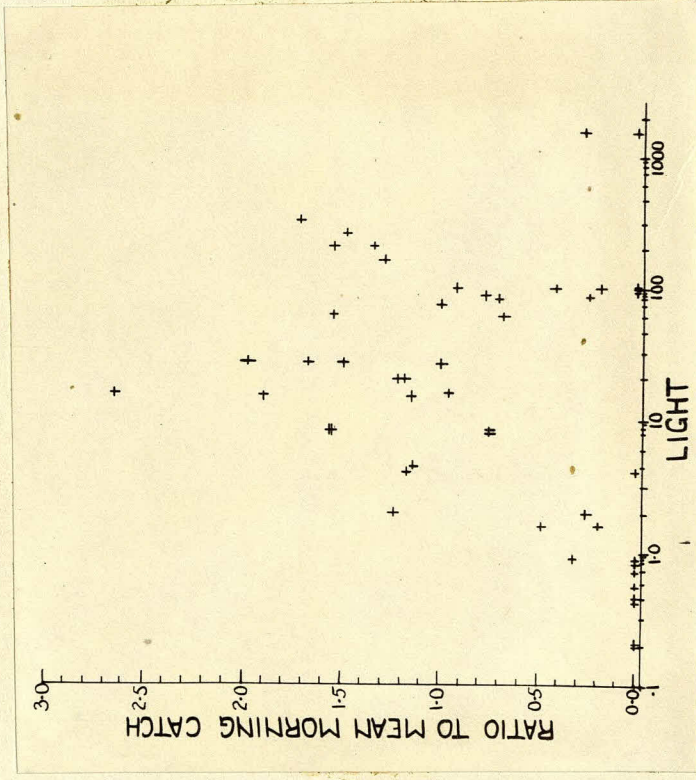
¹Of the six evening collections made in Wytham A during the summer of 1953, every maximum collection occurred when the light was 6.5 c/ft^2 .

2. After the second summer, the light meter was checked and found to have altered slightly: a light of 4 c/ft^2 read as 6.5 on the meter. This means that the correlation with light is even greater than here shown, since the optimum light readings at maximum activity during the first collecting summer (before the meter changed) were about 4.0 , and during the second summer, about 6.5

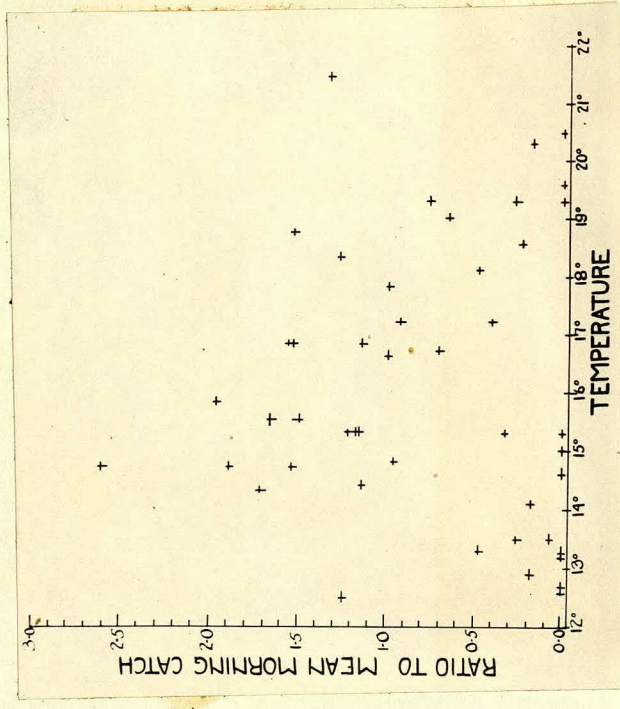
In the woodland collections, the correlation between light and activity is not as clear as in the meadow. This I believe to be due to the difficulty of measuring the light in the woodland to which the flies are responding. Were a more accurate method of measurement available (one which would consider the amount of sunlight and shade over the whole collecting area), a more perfect correlation might be shown. This, however, is by no means certain. Since the flies may be choosing their preferred light (keeping to the darker areas during the brightest part of the day, and the brighter areas when it gets dark) a more accurate method of light measurement might not yield any more perfect correlation. In the meadow, on the other hand, light is uniform, and that measured is clearly the light to which the flies are responding.

FIG. IV-12
MORNING ACTIVITY OF D. SUBOBSCURA IN WOODLAND

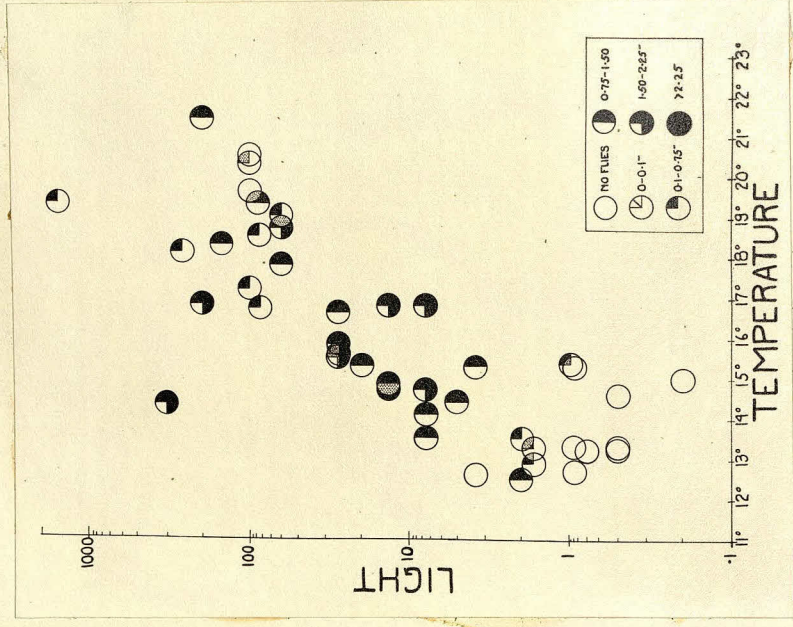
The activity (measured as the ratio of the size of a particular catch to the average size of collection made that day between the beginning of activity and 11 a.m.), in relation to light, temperature, and humidity. Points represent all collections made between the beginning of activity in the morning and 11 p.m. on August 10, 1953 at Wytham A, July 17, and 19, 1952 at Wytham A and B, and August 24 and 31, 1952, at Scoulton, Norfolk, A and B).



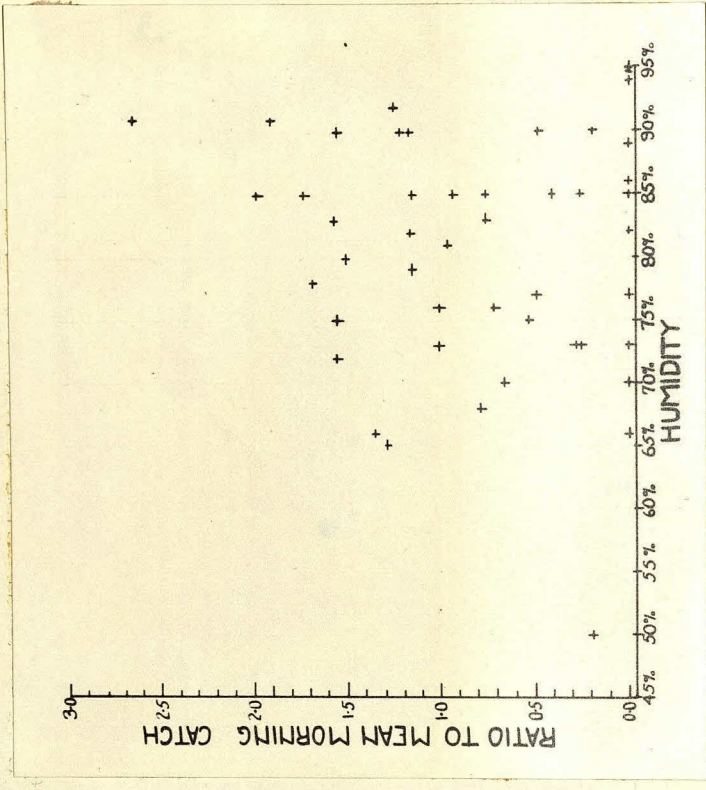
A. Activity in relation to maximum light (measured in candles/ft² and plotted on a log scale).



B. Activity in relation to temperature (measured in degrees centigrade).



C. Activity in relation to temperature and light (position of circles on graph represents temperature and light at time of collection; shaded area indicates activity).



D. Activity in relation to humidity.

Fig. IV-12 summarizes the morning part of 8 all-day collections (Wytham Woods and Scoulton; summers 1952 and 1953). The correlation of activity and light (fig. IV-12A) is less clearcut than in the afternoon collections at the same place. The largest catch was made at a light of $10\text{c}/\text{ft}^2$, whereas during the afternoon, maxima occurred at a light of about $6.5\text{c}/\text{ft}^2$ or lower. In this case, a regression on light intensities below $6.5\text{c}/\text{ft}^2$ is significant ($p. < 0.1\%$) and after light is taken into consideration (but not before) the regression on temperature is significant ($p. < 1\%$). At lights greater than $6.5\text{c}/\text{ft}^2$, on the other hand, a regression on temperature alone is highly significant ($p < 0.1\%$) and there appears to be no residual effect of light. After the regression on light alone ($p. < 1\%$), there is still a significant regression on temperature ($p. < 1\%$). This is difficult to explain, because the lack of correlation between temperature and activity in the afternoon (when temperatures are above 15°C) shows that temperatures above 15°C do not, in fact, inhibit activity. It may be shown that changes in temperature are indicating more accurately than the light meter the changes in light to which the flies are responding. In any case, the effect of both temperature and light in the morning collections would explain why the morning maxima occur later after sunrise than the evening maxima occur before sunset, and also why the morning maxima are in almost every case considerably lower than the evening ones. When the light is at its optimum, the temperature is too low; but by the time the temperature is high enough, the light is too intense.

The low morning peak of activity was also shown in a collection made in Portugal at the end of September (fig. IV-3), where the morning temperature is 12° and the evening temperature is about 22°C. On the other hand, a collection made in Spain in the middle of September (fig. IV-4) shows a higher (and earlier) morning peak; the morning temperature being 19°C, the evening temperature 26°C. These two collections made in Southern Europe by Hadorn et al. together with the data from collections made by me in England indicate an optimum temperature for D. subobscura of about 20°C, and a sharp decrease in activity below 15°C, and possibly also above 25°C. Experimental results support these field observations, and show that D. subobscura has an average temperature preference of about 20°C. This preference is not altered by the temperature at which the flies are raised (p. 165). Collections made in early spring and late autumn (fig. IV-15) support the idea that 15° is a critical temperature, for below that temperature, no large catches were made.

It can be seen, therefore, that in the summer, the peaks of activity of D. subobscura are determined by light, but that temperature has a secondary influence which produces the lower morning maxima under conditions found during an English summer.

The midday decrease in activity seems clearly to be caused by high light intensity. There is a sharp decrease in activity when the light gets above 100 c/ft². Since experiments (p.160-166) indicate that the range of temperature tolerance of D.subobscura extends from below 10°C to above 25°C, this cannot be construed as the effect of high temperature. A temperature of 25° is seldom reached on an English summer day, except in the open meadows, and here activity ceases before the temperature reaches 20°C (fig.IV-7)

Furthermore, the beginning of activity in the morning and its cessation in the evening is very clearly influenced by light. A very few D.subobscura fly below a light of 0.8 c/ft², although temperature seems to have, again, a subsidiary effect. In the morning, when temperatures are low, activity does not begin until the light reaches 1.6 c/ft² whereas in the evenings, it sometimes continues when the light is below 0.6 c/ft² and on one particularly warm evening, there was a sizable catch at a light of 0.4 c/ft². There seems to be a tendency for activity to continue somewhat later on warm evenings.

It is reasonable to conclude, therefore, that light intensity is the most important factor in determining all five phases of summer activity of D.subobscura. Although Hadorn et al came to this conclusion, they did not seem to appreciate the importance of temperature, which can be shown to have a subsidiary effect, even during the summer.²

2. This subsidiary effect of temperature is also true, I believe, for D.pseudoobscura: for in California at 800 ft. elevation, (where high temperatures are quite common during the day) activity continued till it was quite dark, whereas at higher elevations (6-8000 ft.) it ceased much earlier.

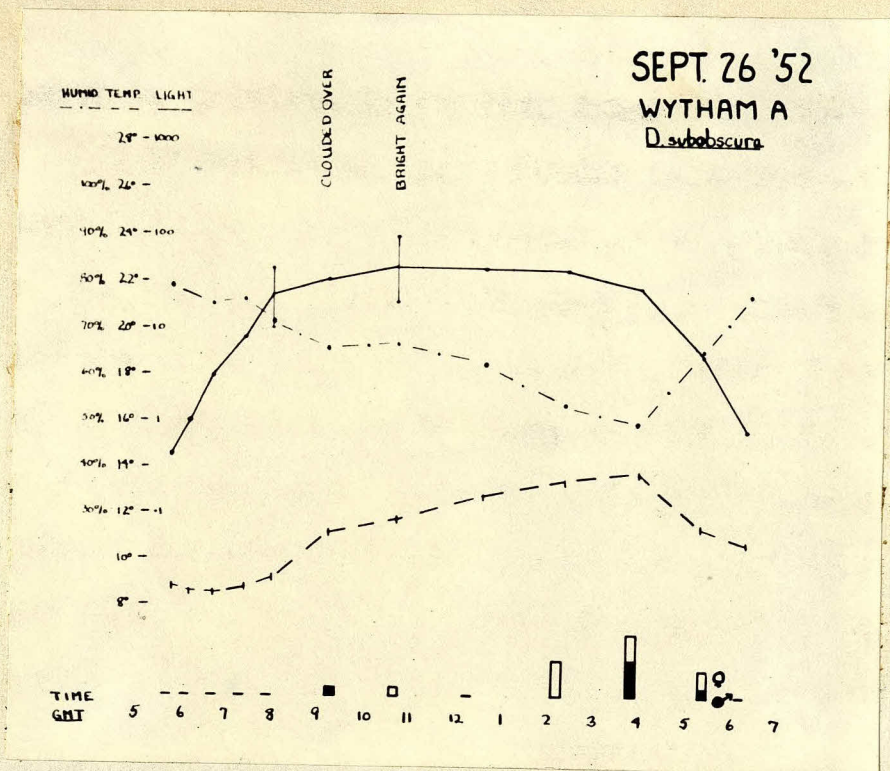


Fig. IV-13. All-day collection showing temperature, humidity, light, and number of D. subobscura caught. Light is represented by — · — · —, temperature by — — — — and humidity by - - - -.

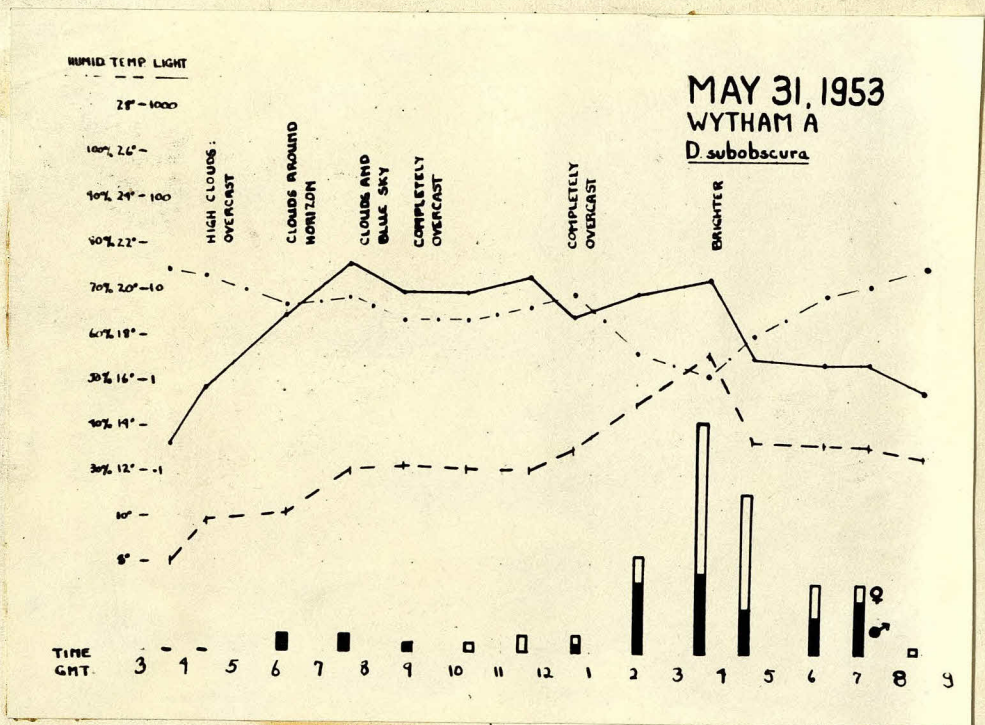


Fig. IV-14. All-day collection showing temperature, humidity, light, and number of D. subobscura caught. Light is represented by — · — · —, temperature by — — — — and humidity by - - - -.

A quite different pattern of activity is found in early spring or late autumn (fig. IV-13 and IV-14). It is clear that there is an increase in activity with increase in temperature. A summary of 'winter' collections (made in September, November, December, January, April and May, 1952 and 1953) shows that there is very little activity below a temperature of 10°C (fig. IV-15). The activity begins above that temperature, but large collections are not made at temperatures below 15°C. Extremes of light still have an effect in reducing collections, although it is clearly less important than temperature.

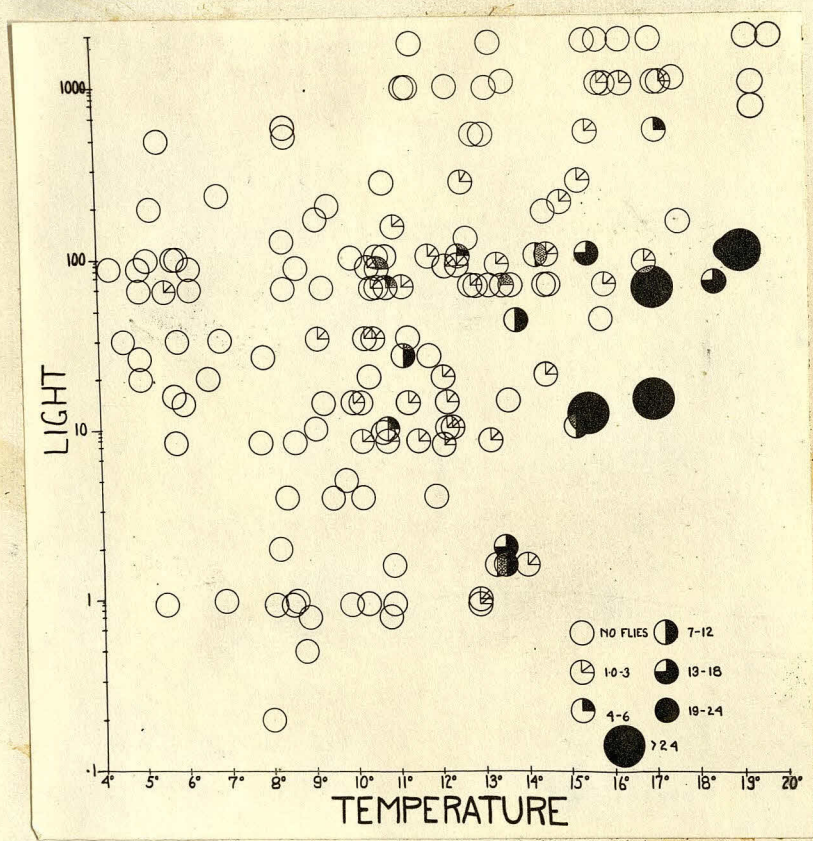


Fig. IV-15. Activity of *D. subobscura* in relation to temperature and light in collections made in September, November, December, January, April and May, 1952 and 1953 (the temperature and light at the time of the collection is represented by the position of the spots; the activity by the black area of the spot).

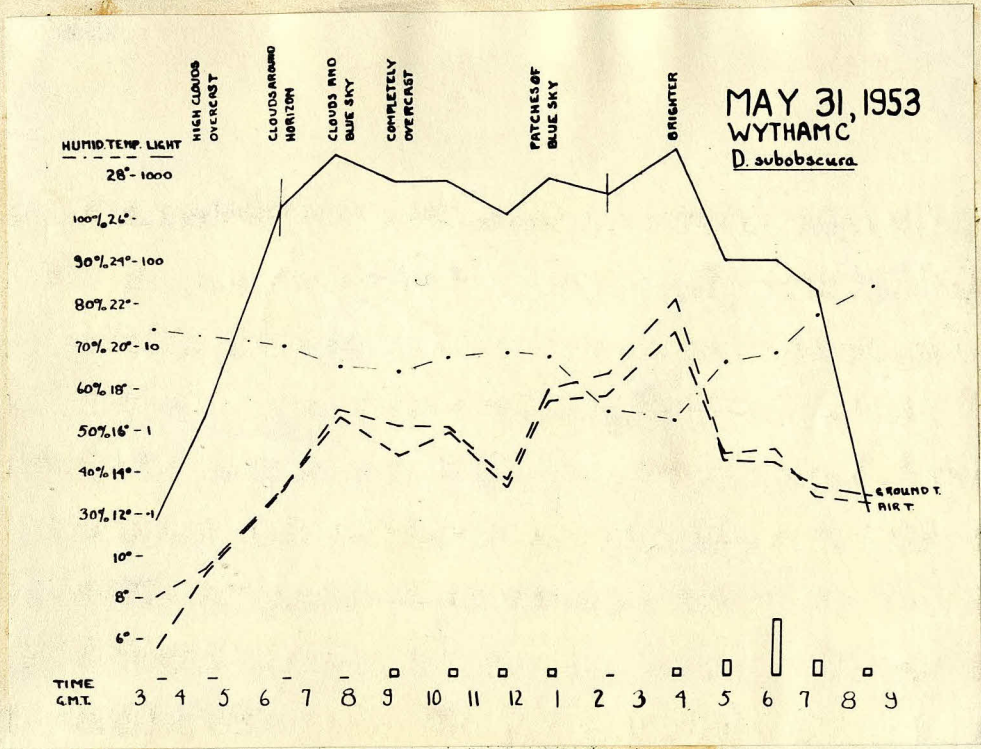


Fig. IV-16. All-day collection showing temperature, humidity, light, and number of D. subobscura caught. Light is represented by ———, temperature by ——— and humidity by - - - -

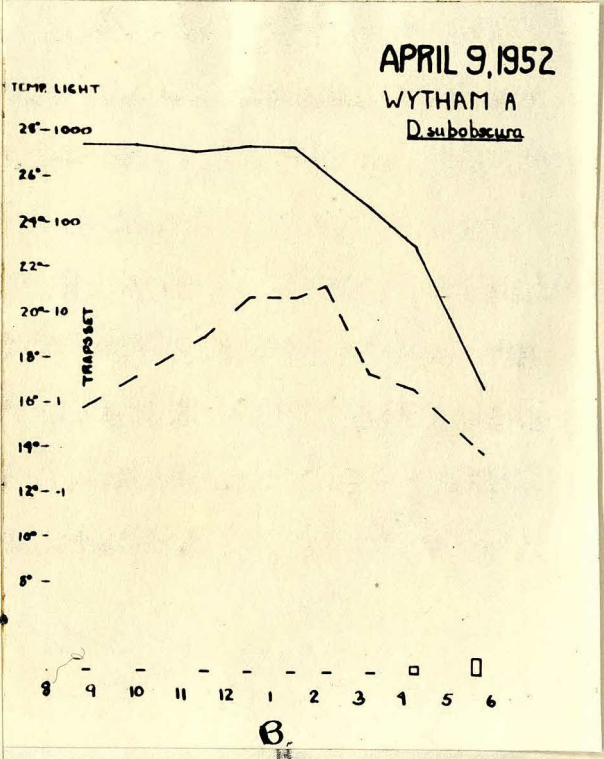
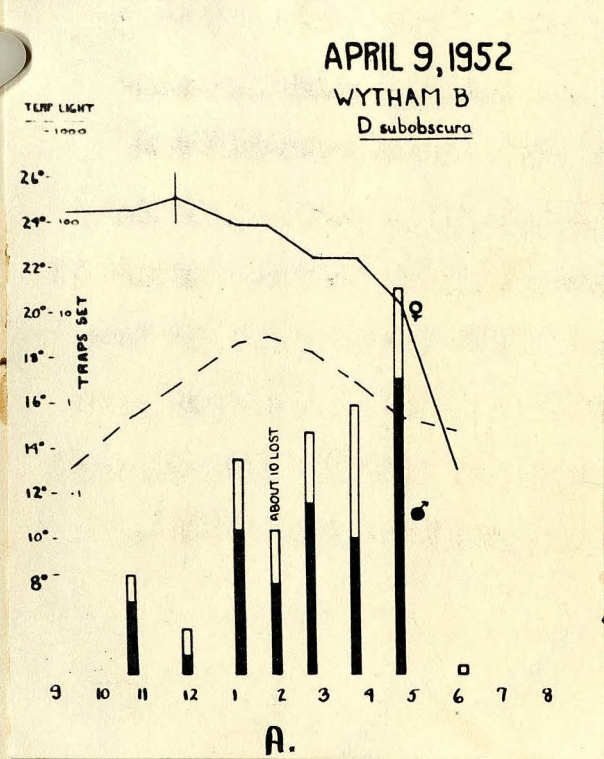


Fig. IV-17. Two part day collections showing temperature, humidity, light and number of D. subobscura caught. Light is represented by ———, temperature by ——— and humidity by - - - - Time is Greenwich Mean Time.

The effect of both factors is shown in a collection made in the meadow (Wytham C: fig. IV-16) in early spring. By the time the temperature had reached 10°C , light was already 800 c/ft^2 , and by the time the light dropped in the evening, the temperature was below 13°C . That a real peak of activity was never reached can be seen by comparing this collection with a collection on the same day in the woodland (IV-14), where the peak of activity came at the highest temperature. In contrast with summer activity, therefore, the pattern of activity found in early spring and late autumn (when temperatures are below 15°C) is determined primarily by temperature and light has only a subsidiary effect. That this activity results from temperature and not the time of year is illustrated by fig. IV-17A. The collection there recorded was made in early spring (April 9, 1952) in a fir wood, yet the pattern of activity - dependent primarily on light - makes it 'summer type' woodland collection. This is because the temperature is above 15°C . The pattern of activity in a deciduous wood (fig. IV-17B) where the leaves were not yet out, is very similar to the May collection in the meadow (fig. IV-16).

In all analyses males and females are considered together. Although Hadorn et al. believe that their collections at Viseu (fig. IV-3) are Berdum (fig. IV-4) indicate a difference in the proportion of sexes at different collecting times, this seems to be based on very little data. In the Viseu collection, there is a rise in the proportion of females throughout the day, which is attributed to rising temperature and increasing light favoring the females. They consider the effect to be less noticeable but nevertheless present at Berdum. In fact the relative proportion of males and females appears to remain remarkably constant during this collection, as can be seen from fig. IV-4. Temperature preference experiments show no significant difference in response of males and females (p. 163); and in all day collections, I could find no consistent differences in the activity of males and females. The one striking difference in behavior is that the males are almost never found in open meadows, but it does not seem possible to explain this on the basis of response to temperature, light, or humidity.

SUMMARY

D. subobscura shows a quite constant diurnal periodicity. The activity in the summer (when temperatures are usually above 15°C) appears to be determined primarily by light intensity. The activity drops sharply at light intensities below and above the preferred one. In the evening, no effect of temperature can be detected either in woodland or meadow collections. In the morning, however, both light and temperature are important. This explains the lower and later morning peak of activity found where morning temperatures are below 15°C.

On the other hand, in the early spring and late autumn (when temperatures are usually below 15°C) activity is primarily dependent on temperature, with light as a subsidiary influence. In deciduous woods and open meadows, a real peak of activity is never reached. Here, when temperatures are above 15°C, the light is far too intense, and by the time the light is low enough, the temperature is too low. In a coniferous wood, however, a quite large collection was made on a warm day in early April.

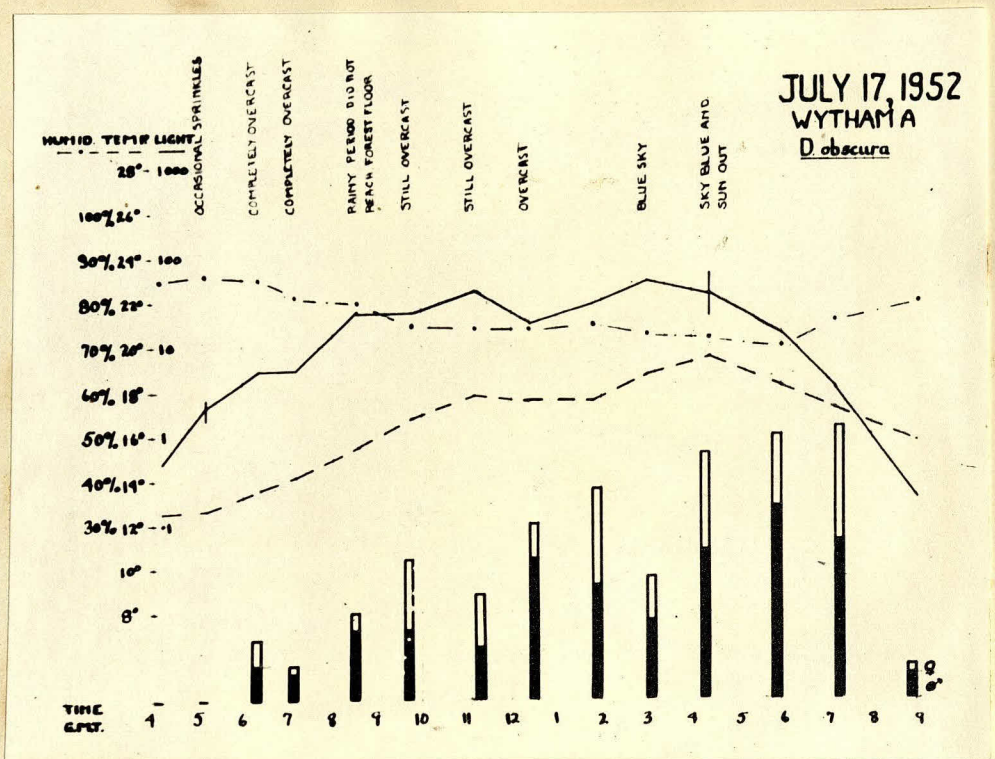


Fig. IV-18. All-day collection showing temperature, humidity, light, and number of D. obscura caught. Light is represented by —, temperature by ---- and humidity by ----.

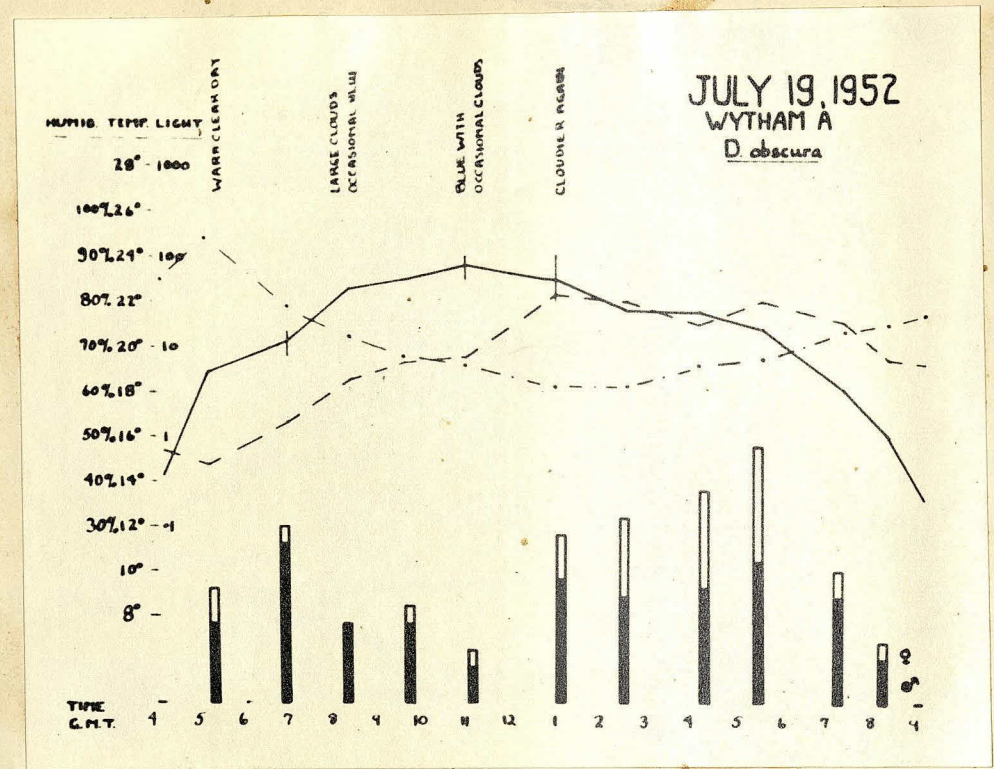


Fig. IV-19. All-day collection showing temperature, humidity, light, and number of D. obscura caught. Light is represented by —, temperature by ---- and humidity by ----.

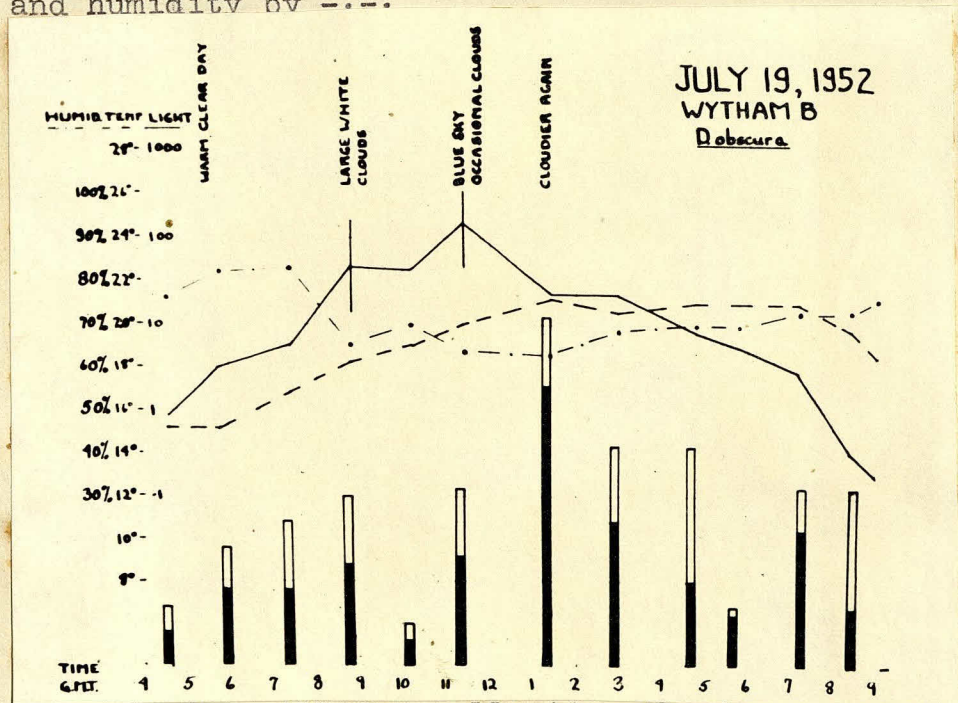


Fig. IV-20. All-day collection showing temperature, humidity, light, and number of D. obscura caught. Light is represented by —, temperature by ---- and humidity by ----.

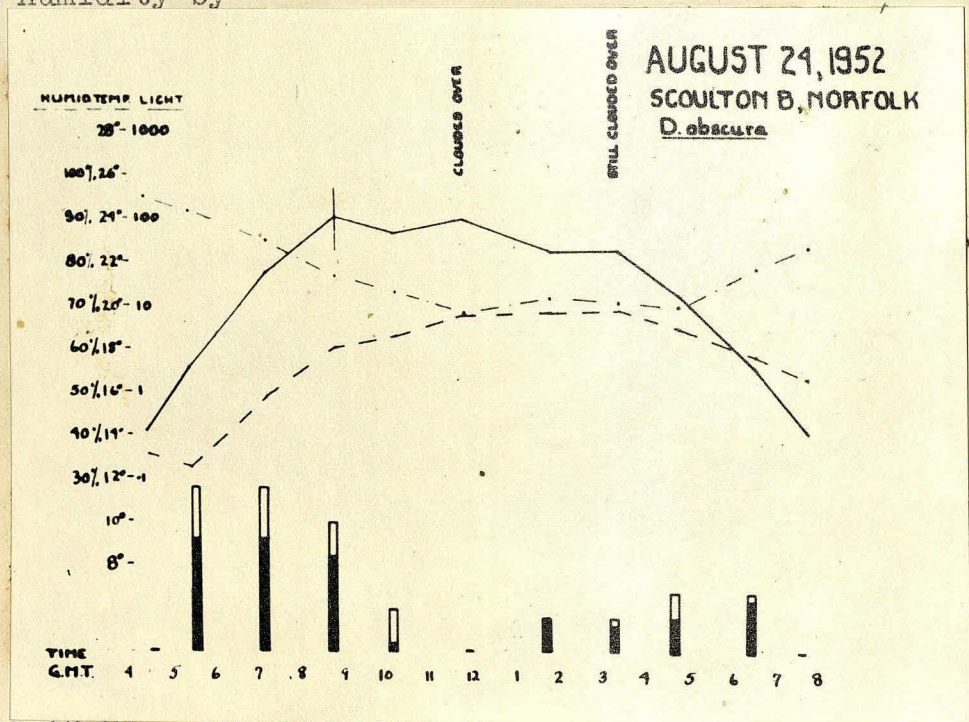


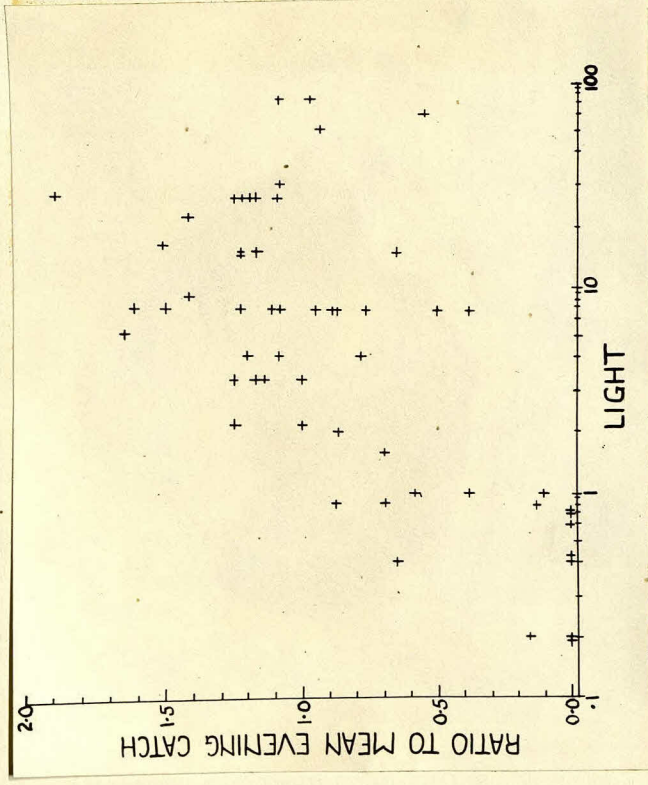
Fig. IV-21. All-day collection showing temperature, humidity, light, and number of D. obscura caught. Light is represented by —, temperature by ---- and humidity by ----.

D. OBSCURA

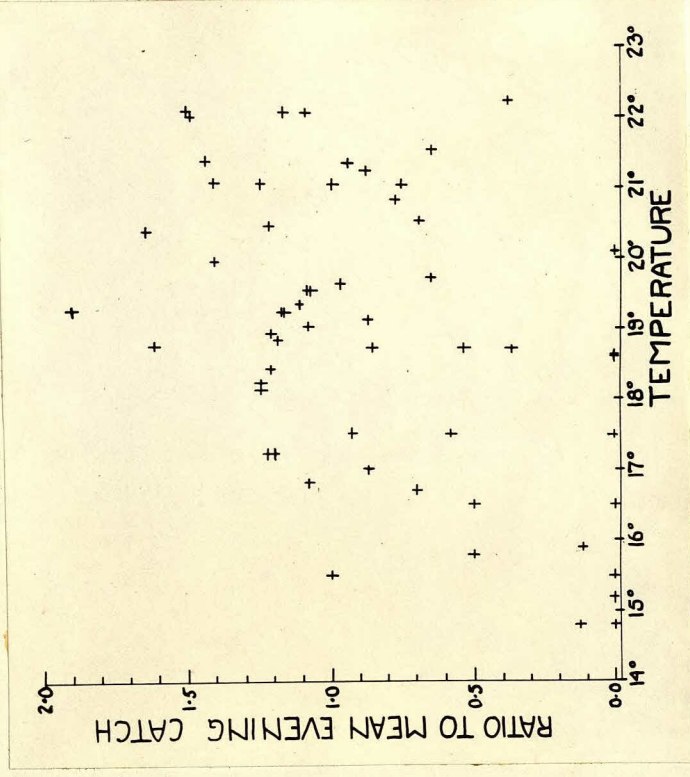
It has not proved possible to make such a detailed analysis of the causes of activity of D.obscura. This species occurs only in woodlands, so that activity in different habitats cannot be compared. Even in woodlands, the pattern of activity varies from day to day. In two collections (July 17, 1952, Wytham A and B), the activity rose to a peak in the evening: in one case a very marked peak (Wytham A: fig.IV-18), in the other, a far less marked one (Wytham B). On two occasions (Wytham A, July 19, 1952: fig.IV-19, and August 19, 1953) there were both morning and evening peaks of activity, the evening peak being higher; and in four collections made in Norfolk at the end of August, the morning peak was higher than the evening one (fig. IV-21). In one collection (Wytham B, July 19, 1952: fig. IV-20) the peak of activity was in the middle of the day (1:30). In no case was the peak as abrupt or as relatively high as in the case of D.subobscura. The different patterns can be explained on the basis of light and temperature, and other fluctuations observed at the time. The one exception is the collections made at Scoulton, Norfolk. in an open woodland. The size of the evening catches of all species was low in relation to the size of the morning catches (app.II p. 7), indicating some general disturbing factor. Unfortunately, this was one of the earlier all-day collections, and no measurement of wind was made.

FIG. IV-22
EVENING ACTIVITY OF D. OBSCURA IN WOODLAND

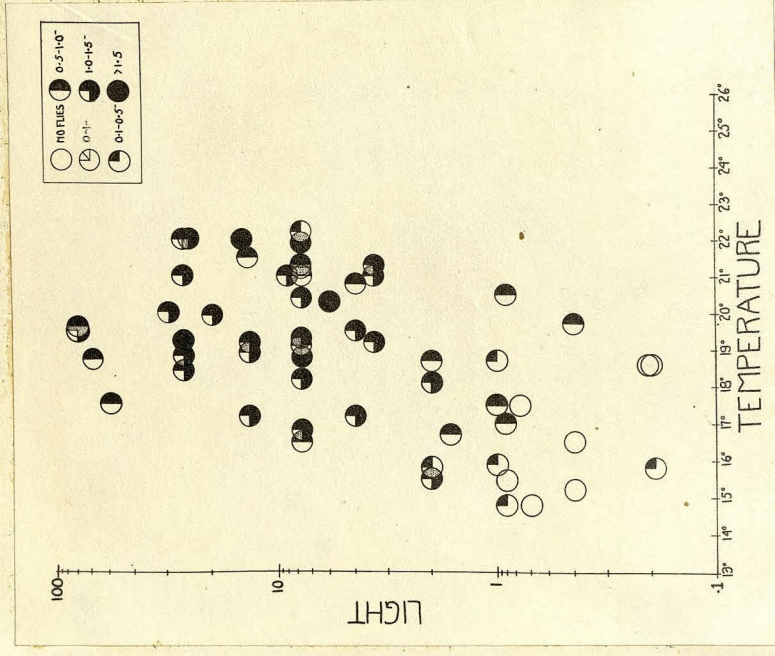
The activity (measured as the ratio of the size of a particular catch to the average size of collection made that day between 2:00 and 7:15 p.m.) in relation to light, temperature, and humidity. The points represent evening collections made at Wytham A and B, July 17 and 19, 1952; and Wytham A, July 10, 29, 30, and August 5, 6, and 10, 1953.



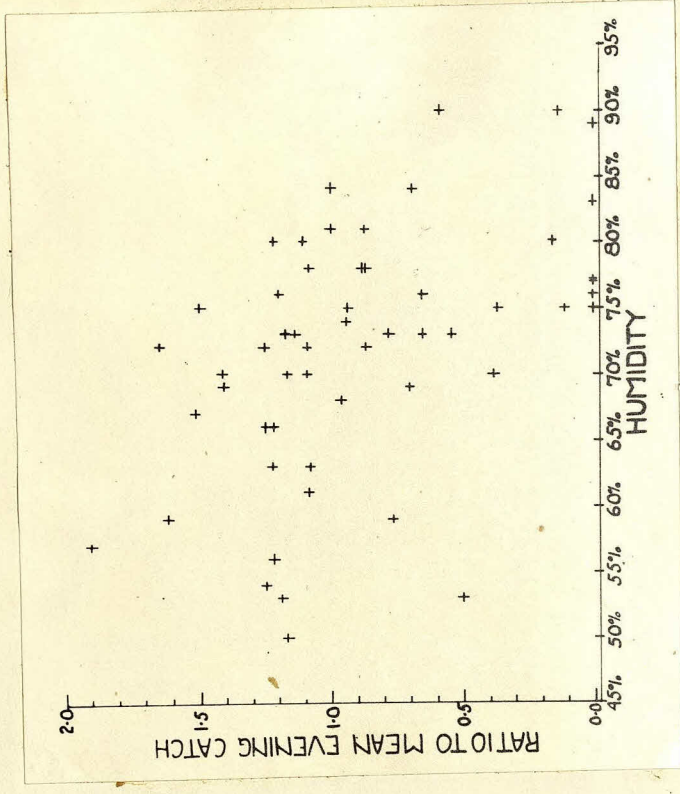
A. Activity in relation to maximum light (measured in candles/lt² and plotted on a log scale).



B. Activity in relation to temperature (measured in degrees centigrade).



C Activity in relation to light and temperature (position of circles on graph represents temperature and light at time of collection; shaded area indicates activity).



D. Activity in relation to humidity.

Fig. IV-22 is the summary of afternoon collections made in dense woodlands (Wytham A and B) during the summers of 1952 and 1953. There seems to be a clear drop in activity below a light of about 4 c/ft², and above 50 c/ft². But within that range, there is no clear optimum light. This is also shown (fig. IV-18 through IV-21) in the very broad peaks of activity (much less abrupt than those of D. subobscura) and also in the greater variability of pattern of activity. The general pattern of activity seems to be: the beginning at dawn, a cessation at night, usually with an overall increase during the day (as temperature increases), and fluctuations due to periods of too intense sunlight.

The mathematical analysis shows a significant regression in morning collections of temperature and light below 6.5 c/ft² with number of flies caught ($p < 1\%$). In the evening there is a significant regression with lights below 6.5 c/ft², ^($p < 1\%$) and no residual effect of temperature after light is considered. The effect of temperature in the morning but not in the evening agrees with D. subobscura, and is probably again due to temperatures below 15°C inhibiting activity. At lights greater than 6.5 c/ft², there is no notable regression either with temperature or light. There seems to be a drop in activity in the few collections when light was about 50 c/ft², but there is apparently not enough data for this to effect the regression. There is a significant regression on humidity, taken by itself ($p < 5\%$), but after taking light or temperature into account, there is no residual effect.

Thus, it seems that D. obscura is responding to low and possibly high light intensities, and low temperatures, but has a wide range of tolerance to light and temperatures. D. sub-
obscura, on the other hand, shows response to low, and possibly high temperatures, but has a very definite light preference.

Fig. IV-23 is a comparison of the light response of the two species

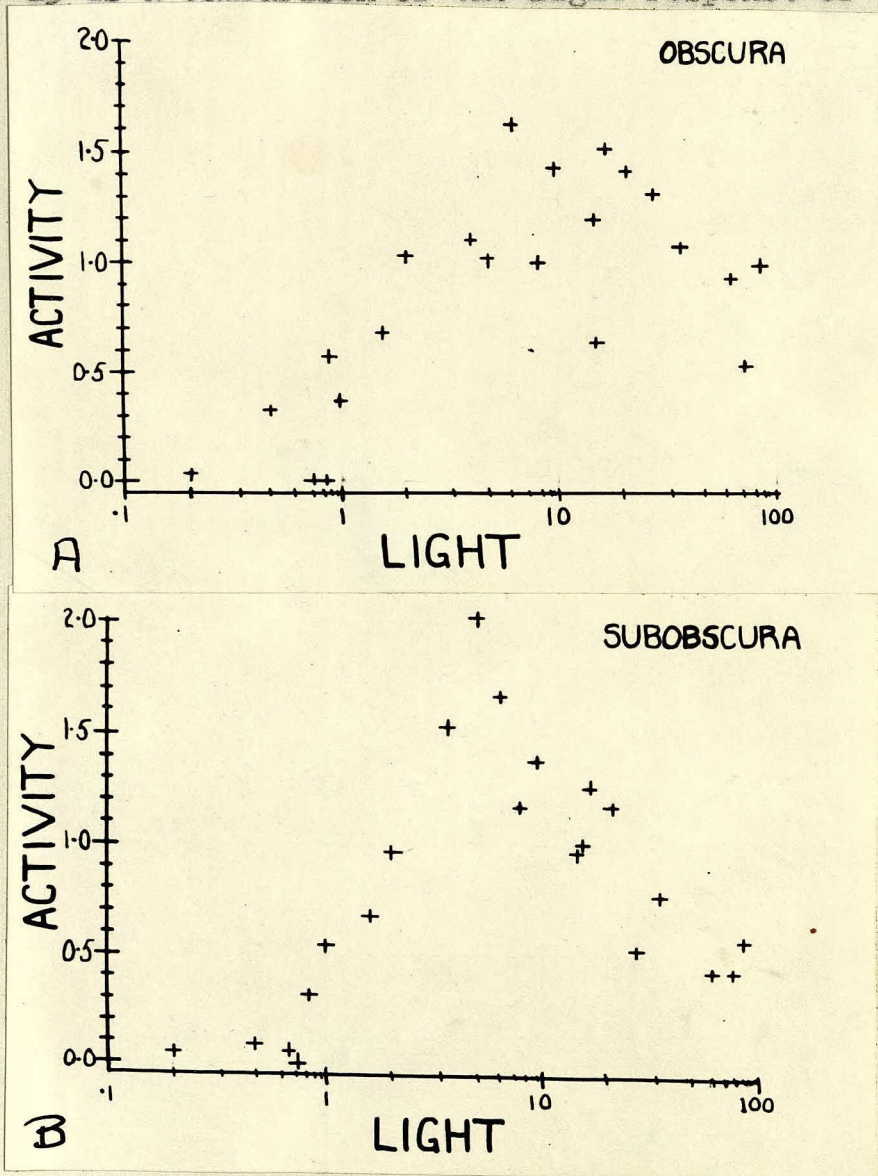


Fig. IV-23. The activity (measured as the ratio of the size of a particular catch to the average size of collection made during the evening) in relation to light. A. D. obscura. B. D. subobscura

D. TRISTIS

Hadorn et al. consider D. tristis to be decidedly a morning species. This is not confirmed by my collections. Of the 327 specimens of D. tristis caught in the course of 9 all-day collections, 43% were caught in the evening, and 57% were caught in the morning. The percentage of D. tristis caught in the morning and evening was almost identical for all collections except those made at Scoulton, Norfolk, in August, where the evening collections of all species were very small, and D. tristis was particularly abundant. The collections at this single locality are responsible for the higher overall percentage of morning catches.

QUINARIA GROUP

Not enough specimens of these species were caught to allow determination of their activity-patterns. Specimens were caught throughout the day, but there seemed to be a tendency for the maximum numbers to be caught at the same time as the maximum number of D. subobscura. (App. II, pp. 1-18).

D. DEFLEXA

This species occurs in large numbers only in mid-summer, so that only five of the nine all-day collections gave any indication of its daily activity. There is no consistent time of peak activity, but the afternoon collections gave an indication of greater activity on warmer days (App. II, pp. 12-18). The

tendency of this species to become active later in the morning than either D.obscura or D.subobscura and the fact that it is only abundant during the middle of the summer gives support to the idea that this species is more sensitive to temperature than is the case with the species discussed above.

D. CAMERARIA (pallida)

This species is caught sporadically, seldom in large numbers. On one morning, however (Wytham B, July 19, 1952), it made up 36% of the 100 flies caught at 5:30 a.m., G.M.T. And on the few occasions when specimens of D.Cameraria were obtained in collections, it was always either early morning (usually before 6:30 a.m.) or late evening (after 6:30 p.m.). With this species, there was a clear indication of greater activity in the morning than the evening. Of the 112 specimens caught during all-day collections (App. II, 1-11), 89% were caught during the morning (in all cases before 7:30 a.m.) and 11% were caught in the evening (in all cases after 6:30 p.m.). This species made up almost 1% of the 70 flies caught during the months of November, December, and January, whereas it constituted an exceedingly small fraction of the flies caught during the summer. This, together with the fact that it is more frequent in the morning than in the evening, may indicate a preference for lower temperatures.

D. MELANOGASTER

Since my collections were made in woodlands quite far from human habitation, I did not get sufficient numbers of this species to determine anything about its periodicity. During one collection at Berdum, Spain (fig. IV-4), Madorn et al. (1952: 141) show that D. melanogaster has a morning and evening peak of activity. However, at another locality in Southern France on a uniformly cloudy day, a clear daily periodicity was not found. Timofeef-Ressovsky (1940a: 31) found 46 flies of this species between 5:00 and 10:00 am; 3 between 12:00 and 4:00 pm; 84 between 6:00 and 10:00 pm and none between 12:00 and 4:00 am. These data would indicate that D. melanogaster has a morning and evening peak of activity, but that it is less marked on a cloudy day.

CHAPTER V

LABORATORY EXPERIMENTS WITH
D. OBSCURA AND D. SUBOBSCURA

The most obvious explanation for the restriction of D. obscura to the woodland might seem to be the influence of humidity. To obtain more information about the responses of D. obscura and D. subobscura to temperature and humidity, experiments were conducted to test the reaction of the two species to temperature and humidity gradients.

Rather than measuring the activity of the flies at different temperatures, response to a temperature gradient was studied, because observations showed that the flies' activity increases steadily with temperature, until the heat kills them (above about 35°C). Since a measurement of this sort of activity would give no indication of the response of the flies in the wild, where they have a great variety of temperatures they can choose, it seemed best to measure their preferred temperature. It seems reasonable to assume that the time of maximum activity in the wild would be when the air is at the preferred temperature (all other factors being equal).

The apparatus used was described by Valerie Todd (1949: 223). It consists of two insulated metal chambers (8 in. by 9 in. by 10 in.) connected by a solid brass trough (26 in. long by 2½ in. wide by 1 in. deep), which is also insulated (fig. IV-1). Fine cotton gauze, stretched over

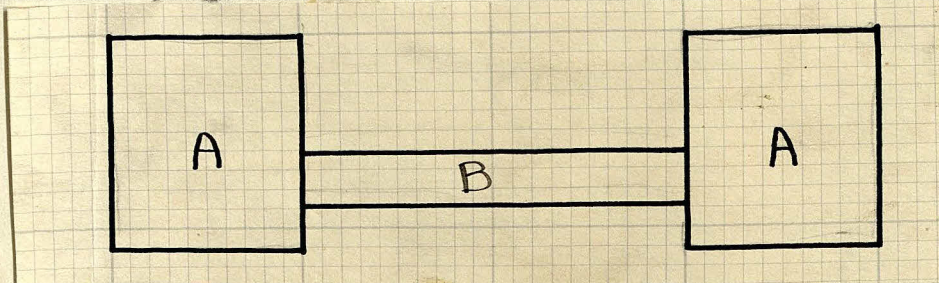


Fig. IV-1. Apparatus for measuring temperature preference of small invertebrates. A are the insulated metal chambers for hot and cold water. B is the insulated brass trough.

wire, provides a false floor to the trough and gives a suitable surface for the animals to walk on. A strip of glass is fitted over the gauze, leaving a space about $1\frac{1}{2}$ in. wide by $\frac{3}{16}$ in. deep for the flies to move about. (The low long chamber has the advantage that, though the flies can move about with perfect ease, and orient themselves with respect to temperature, they cannot change their position quickly if startled by an observer coming near to note their position.) A second strip of glass is fitted over the top of the trough, to complete the insulation (fig. V-2). Boiling water and ice are put in the two chambers, and after an hour, an even gradient of temperature is established. The length of the trough was calibrated in degrees centigrated by placing thermocouples at 6 cm. intervals, and interpolating intermediate values.

The experimental procedure was as follows. Ice was placed in one chamber, and the electric unit connected to heat the water in the other chamber. The gauze at the bottom of the trough was moistened, more at the hot end than at the cool (to try to counteract the humidity gradient). The apparatus was

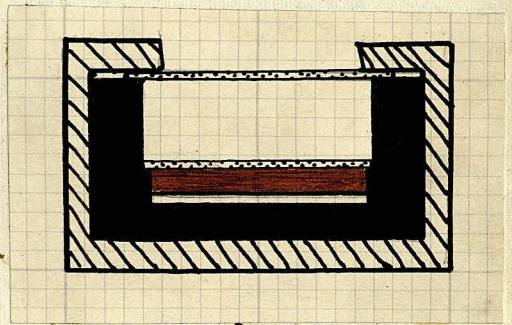


Fig. V-2. Cross section of the trough of the apparatus for determining temperature preference. The black represents the brass trough; the cross-hatched area, the insulation; the stippled areas the glass; and the brown area the chamber for the flies (above the gauze bottom, and below the lower sheet of glass).

left to establish a gradient. After an hour, about 50 etherized flies were distributed evenly over about 24 cm. length of the trough (not in the regions of low temperature, nor in the regions where the temperature was hot enough to kill the flies). The usual gradient used started at about 10°C. The flies can stand temperatures below 0°C, but when they get to temperatures below 10°, they become exceedingly sluggish. Any flies which reach the lower range of temperatures stay there, and gradually accumulate at the cold end (though it is clearly not the preferred temperature). At the other end, the flies could not stand temperatures above about 32°C, and any which reached that part of the gradient rapidly moved. If they moved in the wrong direction, to the regions of even higher temperature, they died extremely quickly. When the flies had been in the gradient for an hour, their position was noted, and the respective temperatures were recorded. The flies were then removed.

The main object of the experiment was to determine if there was a difference in temperature preferences of D. obscura and D. subobscura. Experiments were planned so that males and females were tested separately, whenever possible. The strain of D. obscura tested was from Premeno, Italy. Two strains of D. subobscura were tested; one from Pavia, Italy (kept under laboratory conditions for many generations); the other from Bagley Wood, near Oxford (about the 3rd and 4th generation descendants of approximately 100 females caught in November, 1953).

The Bagley strain was split and cultures were raised at 10°C, 20°C and 32°C (for one generation only) to see if the environmental temperature affected the preferred temperature. Those raised at 10°C were perfectly healthy, but it was difficult to get large numbers, since the mold developed more rapidly than it could be eaten by the slowly developing larvae. A number of the cultures, therefore, did not produce offspring; and since a generation took two months at this temperature, it was difficult to get enough flies to experiment with. Those raised at 32°C developed very rapidly, but were small, and with many deformities (such as bent wings and crooked abdomens). 20°C seemed to be the optimum temperature for raising flies of this species.

The results of the experiments were as follows:

Strain	Mean preference	Number of experiments	Number of flies tested			Total
			♂♂	♀♀	♂♂ and ♀♀	
<u>D. SUBOBSCURA</u>						
Bagley 10°C	21.6 ± 1.32	2	-	-	68	68
Bagley 20°C	19.7 ± 0.50	10	145	328	-	473
Bagley 32°C	21.5 ± 0.55	7	155	238	-	393
Pavia 20°C	21.1 ± 0.57	8	125	309	-	434
<u>D. OBSCURA</u>						
Premeno 20°C	18.2 ± 0.50	11	144	255	82	481

In all the experiments, the reactions of the males and females were analysed separately, and in no case was there any indication of a difference in response between the sexes. The 1.8°C difference in temperature preference between the Bagley strain of D. subobscura raised at 20°C and that raised at 32°C,

though small, is significant (but only at the 5% level). However, the average preferred temperature of the same strain raised at 10°, though only based on a small sample, is highest of the three. These experiments show that the temperature at which D.subobscura is raised does not greatly alter the preferred temperature.

The difference in temperature preference between the Bagley and Pavia strains of D.subobscura is not quite significant though the higher preferred temperature of the Southern strain might indicate that the difference is not due to chance alone. The difference, however, is very small. The average temperature preference of all the samples of D.subobscura is 20.7°C, and this agrees well with the 20°C optimum indicated by field data (p.148).

The difference of temperature preference of D.obscura and the Bagley strain of D.subobscura is significant at the 5% level; that of the Italian strains of the two species is significant at the 1% level. Again, the difference is small and not sufficient to explain the fact that D.obscura is found only in woodlands, while D.subobscura has been able to colonize open meadows as well as woodlands.

As a result of the accumulation of flies at the cold end of the gradient, the curves are not normal, and it is not possible to determine the fiducial limits of the distributions of the two species in the gradient. However, the upper limit of temperature tolerance was quite clear. It was as follows:

Strain	Average maximum	Observed range
<u>D. SUBOBSCURA</u>		
Bagley 10°C	29.5	28.8 - 29.7
Bagley 20°C	30.2	29.4 - 31.8
Bagley 32°C	30.5	28.4 - 32.7
Pavia 20°C	30.7	27.6 - 34.5
<u>D. OBSCURA</u>		
Premeno 20°C	27.8	24.0 - 33.1

This is a very crude measurement, sometimes dependent on the presence of a single fly. Yet there is a remarkable consistency of the maximum temperature at which D. subobscura flies were found, regardless of the strain or the temperature at which the flies were raised. The maximum temperature tolerance of D. obscura seems to be somewhat lower, but again, not sufficiently so to explain the fact that this species is confined to woodland habitats.

SUMMARY

D. subobscura shows an average temperature preference of about 20°C, which agrees well with the optimum inferred from field data. The temperature preference is not greatly altered by the temperature at which the flies are raised. This is obviously important in predicting the behaviour of the flies in the wild, since it indicates that the flies are probably reacting similarly with respect to temperature at different times of year.

D. obscura shows a lower temperature preference of about

18°C. However, the difference in temperature preference between the two species is not great enough to explain the fact that D. subobscura can live in woodlands and meadows, whereas D. obscura is confined to woodlands.

The response to humidity of the two species was more difficult to measure, since small differences in light had more influence on the distribution of the flies than large differences in humidity. However, the following procedure seemed to overcome, as far as possible, the presence of uneven light.

The apparatus was a glass tube 1 in. in diameter and 1 ft.

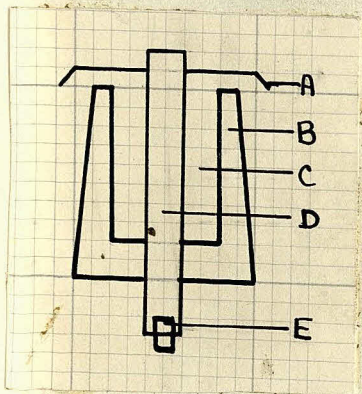


Fig. V-3. Longitudinal section through A, cotton gauze; B, cork; papers, as described by Solomon (1945:1952). C, space for CaCl_2 , or wet cotton wool; D, glass tube; E, cork

long with a cork at both ends, one with wet cotton wool, the other with calcium chloride (fig. V-3). The tube was left for 48 hours (the cotton wool being moistened every 24 hours) for the gradient to establish itself. Humidity was measured by cobalt chloride and cobalt thiocyanate

After 48 hours, the flies were introduced through a glass tube in the cork (alternately at the dry and the wet in successive experiments). The apparatus was then covered with a box, 14 in. long by 3½ in. wide by 3 in. deep, blackened on four sides, and with translucent paper on the 5th (a long side), which was placed parallel to a long window. All experiments were made between 6:45 and 8:45 p.m.

(or after 5:00 p.m. if the day was very overcast) so that the light would be diffuse and as even as possible. After 15 minutes, the position of the flies was recorded, the light measured with a Weston meter, and the direction of the tube then reversed. A second reading was taken 15 minutes later, and the light was again measured. The results of the two readings (parts A and B of each experiment) were combined for the analysis, to counteract the effect of greater light intensity at one or the other end of the gradient. In no case was the light greatest in the middle of the gradient.

In the humidity gradient the flies are exceedingly active, in contrast to the temperature gradient, where the flies are relatively inactive. Since it was impossible to record the position of all the flies simultaneously, some individuals might be counted twice, or not at all. Also, the flies which were sitting on the cotton gauze at the ends of the tube were not recorded, since it provided an added area for sitting, and would make the two end sections of the gradient not comparable with the others. For this reason, the number of flies recorded in parts A and B of one experiment is not always identical. The tube was marked off into 1 in. sections, and the number of flies in each section was recorded.

The gradient, though slightly steeper at the two ends, was quite even, and consistent from one experiment to another. It was very little disturbed by the introduction of the flies.

Below are summarized the results of 6 experiments with D. subobscura and 5 with D. obscura (Tab. I). The accuracy of the humidity readings is approximately $\pm 5\%$. To facilitate the reading of the humidities, only 6 papers were inserted, approximately in alternate sections. For this reason, humidities are not given for each section.

Section	TABLE I												Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Humidity	30%		45%		55%			75%		85%		100%	
% total no	18.6	13.5	8.5	6.9	8.2	7.3	5.5	4.8	8.0	5.2	5.5	8.2	564
D. sub.													
% total no	17.6	11.7	10.1	9.3	5.9	9.7	6.6	9.5	5.7	5.5	4.6	3.7	454
D. obscura													

It will be seen that there is a tendency for accumulation at the drier end, which seems more abrupt in D. subobscura and more gradual in D. obscura. In both cases, however, the lowest humidity available was the one most sought. The smallest differences in light influenced the orientation of the flies considerably. Tables II and III give the results of the two parts (A and B) of each experiment, showing the difference in orientation when the direction of the experimental tube was reversed. The results are given as the ratio of the number of flies in sections 1-6 (the dry end, D) to the number of flies in sections 7-12 (the wet end, W), and are shown for parts A and B, and for the total experiment.

Table II

The Response to D. subobscura to both Humidity and Light

Experiment	Light (in C/ft ²)		Number of flies		D/W (A & B)	Average D/W
	D	W	D	W		
1A	-	-	24	18	1.33	1.47
B	13 ⁺	13 ⁻	28	14		
2A	25	25	23	17	1.35	1.19
B	10	10	20	19	1.05	
3A	.8	.8*	25	27	0.93	1.41
B	.8 ⁻	.8 ⁻	27	10	2.70	
4A	8	8	34	22	1.54	1.69
B	13	13	25	13	1.92	
5A	15 ⁻	15	32	17	1.88	2.41
B	15	15 ⁻	38	12	3.17	
6A	10 ⁻	10 ⁻	39	27	1.44	1.98
B	6.5 ⁺	6.5 ⁻	40	13	3.07	

* Light differences at this low intensity were not measurable. However, the illumination was not uniform.

It is clear that in experiments where the light was even, there was very little difference between the A and B part of each experiment. When the light was only slightly uneven, however, there was a considerable difference between the two parts of each experiment. The flies appear

to be responding far more to small differences in light than to large differences in humidity.

D.obscura shows the same kind of reaction both to light and humidity (Tab.III).

Table III

The Response of D.obscura to both Humidity and Light

Experiment	Light (in C/ft ²)		Number of flies		D/W (A&B)	Average D/W
	D	W	D	W		
1A	4.0	4.0	43	17	2.53	1.81
B	3.2	3.2 ⁻	33	25	1.32	
2A	3	3 ⁺	26	37	0.96	1.58
B	4 ⁺	4 ⁻	48	11	4.36	
3A	15 ⁺	15 ⁻	39	19	2.05	1.72
B	13	13 ⁺	35	24	1.46	
4A	5	5	18	11	1.64	2.31
B	1.6	1.6	19	5	3.80	
5A	20	25 ⁻	10	14	0.71	1.39
B	20 ⁺	20	22	9	2.44	

The difference between the A and B readings in the same experiment indicate that the flies are responding to very small differences in light.

Summary

Both D. obscura and D. subobscura appear to prefer lower humidities (considerably lower than those encountered during an English summer day, even in the open meadow). (This same preference for lower humidities was also found by Dakshinamurthy (194-: 339-357) for the house fly, musca domestica.) The ratio of the number of flies at the drier end of the gradient (humidities of 30%-65%) to the number at the moister end of the gradient (humidities 70%-100%) is 1.7; almost identical for the two species of Drosophila. The distribution of the two species along the gradient seems to differ, however. The numbers of D. subobscura rise sharply at humidities below 45%, whereas the numbers of D. obscura appear to increase more or less steadily along the whole length of the gradient as the humidity decreases. With both species, small differences in light influence the orientation considerably, while larger differences completely override the orientation due to humidity. In any case, a difference in humidity preference cannot explain the fact that D. obscura is confined to the woodland, while D. subobscura occurs in many different habitats.

CONCLUSIONS

Pavan, Dobzhansky and Burla (1950: 42) conclude that, since it has been found that D. pseudoobscura and D. persimilis die within 38-53 hours at 0 per cent relative humidity and within 57-93 hours at 95 per cent relative humidity (at 24°C), "loss of water is....a great hazard to which Drosophila flies are exposed in nature." They consider the diurnal periodicity of Drosophila to be an adaptation to temperature and humidity, but add: "Although this behavior is an adaptation to humidity and temperature conditions of the environment, it does not necessarily follow that it is evoked by humidity and temperature changes."

The species of Drosophila I studied can orient with respect to both temperature ^{and humidity} (D. subobscura and D. obscura choosing lower, rather than higher humidities). Yet the field data (Chapter IV) show that, although the flies are extremely sensitive in their light response, there is very little correlation of activity with air temperature, and none with humidity. Were environmental humidity and temperature the critical factors (as the above authors suggest) it would seem reasonable to suppose that the responses to these factors would have been selected for, rather than the response to light intensity. The fact that Drosophila (particularly D. subobscura are so sensitive in their light response would rather indicate that the critical

factor is closely related to light (as measured by a light meter). It might be that humidity and temperature are secondary factors, the radiation of the sunlight producing temperatures above the 'critical temperature' of the cuticle¹. and thereby causing desiccation of the fly. However, a great deal more information is needed before the adaptive significance of the diurnal periodicity of Drosophila can be assessed.

1. The temperature above which the wax layer of the cuticle shows an abrupt increase in permeability to water (Wigglesworth 1945: 112).

CHAPTER VI

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

Of the twenty-eight species on the British check list, the twenty-two representatives which I caught all appear to be good, non-intergrading species. Twenty-one of these species fit into the subgenera and species groups outlined by Startevant and others; while seven have not as yet been studied in sufficient detail, since they are relatively rare.

England appears to be on the outer margin of Drosophila distribution. This conclusion is based on the following facts:

1. In England, there are only 28 species of Drosophila, whereas in the tropics, there are many more (in one area ~~locality~~) of Mexico, 89 species were caught.

2. In Switzerland, Burla found eleven species dominant (i.e. most abundant) in woodland habitats; I found only five. D. subobscura was dominant in most woodland habitats in England, and this is the species which seems to have the widest range of habitat tolerance.

3. In the general world distribution, over 90% of the Drosophila species of any zoogeographical region are endemic to that region; in England, only 65% of the Drosophila are palaeartic species.

D. helvetica is the only species which is clearly

limited in its geographical distribution, the critical factor in which appears to be low winter temperatures. Of the other species, eleven were caught in large enough numbers to assess their geographical distribution, and all clearly vary in frequency more with habitat than with general geographical area.

The relative frequency of the various species was found to vary:

1. From day to day (probably due to differences in weather).
2. In different types of habitats (the cosmopolitan species were more frequent around human habitation) and even in different, though neighbouring woodlands the species frequencies were very different. It was not possible to correlate the abundance of a particular species with a certain kind of plant.
3. At different times of year in the same habitat.
4. With time of day (due to the different patterns of diurnal periodicity of the different species).

The pattern of daily activity of D. subobscura and D. obscura was found to differ considerably. D. subobscura, having a very narrow range of optimum light, has abrupt peaks of activity in the morning and evening. D. obscura, having a wider range of optimum light, which is seldom exceeded in the woodland shade during the day, shows no regular peaks of activity, but merely slight fluctuations during the day. The activity of both species shows a strong positive correlation with low light intensities; but only D. subobscura shows a strong negative correlation with higher light intensities. There is a secondary

effect of temperature in each case. The activity of both species is inhibited by temperatures below about 15°C; and collections made in Southwest Europe by other workers indicate an optimum temperature of about 20°C.

In the winter, on the other hand, when temperatures seldom go above 15°C, the pattern of activity is determined primarily by temperature, with a secondary effect of light. In no case was there any noticeable effect of humidity.

Experimental results corroborate these field observations. Both species were found to choose temperatures around 20°C, the temperature preference of D. obscura being slightly lower than that of D. subobscura. This difference in temperature preference is not great enough to explain the fact that D. obscura is confined to the woodland, whereas D. subobscura does go into the meadow. Neither species showed a marked humidity preference; there was a tendency for both species to accumulate at lower humidities, but small differences in light completely overrode large differences in relative humidity. Pavan, Dobzhansky and Burla state that even though Drosophila are responding to light, the diurnal periodicity is an adaptation to temperature and humidity conditions of the environment. In view of the extreme sensitivity to light of the species I have studied, this hypothesis seems questionable. The extent to which the

diurnal periodicity of Drosophila is of adaptive significance cannot be assessed until more information is available.

However, observations and experiments indicate that rather than temperature and humidity, it is probable that something associated with light is the critical factor, quite probably radiation.

BIBLIOGRAPHY

REFERENCES

Abbreviations given are those of the 'World List of Scientific Periodicals'. Where this could not be traced, the title is given in full.

Information contained in the various issues of 'Drosophila Information Service' (Cold Spring Harbor, N.Y., U.S.A.) has been utilised in this thesis. Since D.I.S. is not, properly speaking, a periodical, the information given in it comes under the heading of 'Personal Communications' and therefore it is not cited in this list of references.

- BASDEN, E.B. (1952) Some Drosophilidae (Diptera) of the British Isles. Ent. mon. Mag., 88: 200-201.
- BECKER, Th. (1905) Cyclorrhapha Schizophora; Holometopa in, Becker, Th., Bezzi, M., Kertész, K., and Stein, P: Katalog der Paläarktischen Dipteren, 4. (Budapest).
- BRITO DA CUNHA, A., BURLA, H., AND DOBZHANSKY, TH., (1950) Adaptive chromosomal polymorphism in Drosophila willistoni. Evolution, 4: 212-235. Drosophila Heredity.
- BURLA, H. (1948) Die Gattung Drosophila in der Schweiz. Rev. Suisse de Zool., 55: 272-279.
- BURLA, H. (1950) Drosophila grischuna species nova, eine neue Art aus der Schweiz. Arch. Klaus-Stift. Vererb-Forsch. 25: 619-623.
- BURLA, H. (1951) Systematik, Verbreitung und Oekologie der Drosophila-Arten der Schweiz, Rev. Suisse. Zool., 58(2): 24-175.
- BURLA, H. (1954) Zur Kenntnis der Drosophiliden der Elfenbein Küste. (Französisch West-Afrika.) Rev. Suisse. Zool., 61: Fascicule supplémentaire, 1-217.

- BURLA, H., and GLOOR, H., (1952) Zur Systematik der Drosophila-Arten Südwest-Europas. Z. induct. Abstamm.-u. Vererb. Lehre., 84: 164-168.
- BUZZATI-TRAVERSO, A. (1943) Morfologia, Etologia e Biologia di due nuove specie di Drosophila. (Diptera acalyptera). R.C. Ist. Lombardo., 77(8): 37-61.
- BLIGHT, W.C., and ROMANO, A. (1953) Notes on a breeding site of D. americana near St. Louis, Missouri. Amer. Nat., 87: 111-112.
- CAIN, A.J., COLLIN, J.E., and DEMEREC, V.R. (1952) Correct application of the name Drosophila obscura Fallén and notes on the type of D. tristis Fallén. Ent. mon. Mag., 88: 193-196.
- COLLIN, J.E. (1952) Notes on some Drosophilidae (Dipt.), including five additional British species, two of them new to science. Ent. mon. Mag., 88: 197-199.
- COQUILLET, D.W. (1901) Three new species of Diptera. Ent. News, 12: 16-18.
- DAKSHINAMURTY, Sonti. (1949) The common house-fly, Musca domestica, L., and its behaviour to temperature and humidity. Bull. ent. Res., 39: 339-357.
- DEMEREC, M.(ed.) (1950) The Biology of Drosophila. (New York and London).
- DEMEREC, M., and KAUFMANN, B.P., (1945) Drosophila Guide. (Washington).
- DOBZHANSKY, Th., and EPLING, C. (1944) Contributions to the Genetics, Taxonomy, and Ecology of Drosophila pseudoobscura and its Relatives. Publ. Carneg. Inst., 554. (1944).
- DUDA, O. (1924, a) Beitrag zur Systematik der Drosophiliden unter besonderer Berücksichtigung der paläarktischen u. orientalischen Arten (Dipteren.) Arch. Naturgesch., 90(3): 172-234.
- DUDA, O. (1924, b) Revision der europäischen Arten der Gattung Drosophila Fallén (Dipt.). Ent. Medd., 14: 246-313.

- DUDA, O. (1935) Drosophilidae. in Lindner, E: Die Fliegen der paläarktischen Region, 6:(1) 58 &
- ELTON, C. (1947) Animal Ecology. (Third Impression). (London).
- FABRICIUS, J.C. (1787) Drosophila. Mantissa Ins. II, 345, 33.
- FALLEN, C.F. (1823) Diptera Suecica, 2: Geomyzides, 1-8. (Lund.)
- HADORN, E., BURLA, H., GLOOR, H., and ERNST, F., (1952) Beiträge zur Kenntnis der Drosophila-Fauna von Südwest-Europa. Z. indkt. Abstamm.-u. Vererb. Lehre., 84: 133-163.
- HALIDAY, A.H. (1833). Catalogue of Diptera occurring about Holywood in Devonshire. Entom. Mag. I (11): 147-180.
- HARDY, J. (1849) Hist. Berwicksh. Nat. Cl., 2: 359-362.
- HSU, T.C. (1949) The external genital apparatus of male Drosophilidae in relation to Systematics. Univ. Tex. Pub; 4920: 80-142.
- KLOET, G.S., and HINCKS, W.D., (1945) A Check List of British Insects. (Stockport.)
- LABRIJN, I.A. (1948) Het Klimaat van Nederland. (Temperatuur, Neerslag en Wind). Mededelingen en Verhandelingen., A., 53: no. 102.
- LEVER, J., and SOBELS, F.H., (1951) Some remarks on the occurrence of the genus Drosophila in the Netherlands. Koninklijke Nederlandse Akademie van Wetenschappen, Ser. C, 54: 1-6.
- LOEW, H. (1873) Diptera Nova, in Pannonia inferiori et in confinibus Daciae regionibus a Ferd. Kowarzio capta. Berl. ent. Z., 17: 33-52.
- MEIGEN, J.W. (1830) Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, 6: 61-88. (Hamm).

METEOROLOGICAL OFFICE. (1952) Climatological Atlas of the British Isles. (London).

MITCHELL, D.F., and EPLING, C. (1951) The diurnal periodicity of Drosophila pseudoobscura in S. California. Ecology, 32: 696-708.

PATTERSON, J.T. (1952) The genetic relationships of Drosophila littoralis Meigen to the other members of the virilis group. Univ. Tex. Pub.; 5204: 7-19. (1952)

PATTERSON, J.T. (1943) The Drosophilidae of the Southwest. Univ. Tex. Pub.; 4313: 7-216 (1943).

PATTERSON, J.T., and STONE, W.S. (1952) Evolution in the Genus Drosophila. (New York).

POMINI, F.P. Contributo alla conoscenza delle Drosophila (Diptera Acalyptera) europee. Boll. ent. Bologna, 12: 145-164.

SEGUY, E. (1934) Muscides Acalypteres: S.-F. Drosophilinae. in Faune de France, 28.

SOLOMON, M.E. (1945) The use of cobalt salts as indicators of humidity and moisture. Ann. apl. Biol., 32: 75-85.

STURTEVANT, A.H. (1939) On the subdivision of the genus Drosophila. Proc. nat. Acad. Sci., 25: 137-141.

STURTEVANT, A.H. (1919) A new species closely resembling Drosophila melanogaster. Psyche, Camb., Mass., 26: 153-155.

STURTEVANT, A.H. (1921) The North American Species of Drosophila. Publ. Carneg. Inst., 301. (1921) (Washington D.C.).

SCHWEIZERISCHEN METEOROLOGISCHEN ZENTRALANSTALT (1943-53) Annalen. 79-89. (Zurich).

SMART, J. (1945) Drosophila subobscura Collin: Descriptive notes on the species with comments on its nomenclatorial status (Diptera). Proc. R. ent. Soc. Lond., 14: 53-56.

- SALLES, H. (1947) Sobre a genitalia des Drosophilideos (Diptera): I. Drosophila melanogaster e D. simulans. Summa. Brasil. Biol., I: 311-383.
- SPENCER, W.P. (1947) Mutations in wild populations in Drosophila. in, Recent Advances in Genetics, 1: 359-402. (New York).
- STURTEVANT, A.H. (1942) The classification of the genus Drosophila with descriptions of nine new species. Univ. Tex. Pub., 4213: 5-51 (1942).
- TIMOFEEF-RESSOVSKY, N.W. (1938) Genetik und Evolution. Z. induct. Abstamm.-u. Vererblehre, 76: 158-219.
- TIMOFEEF-RESSOVSKY, N.W. (1939) Genetik und Evolutionsforschung. Verh. dtsh. zool. Ges., 41: 157-169.
- TIMOFEEF-RESSOVSKY, N.W., and E. A. (1940a) Populationsgenetische Versuche an Drosophila. I. Zeitliche und räumliche Verteilung der Individuen einiger Drosophila-Arten über das Gelände. Z. induct. Abstamm. Vererblehre, 79: 28-34.
- TIMOFEEF-RESSOVSKY, N.W., and E.A. (1940b) Populationsgenetische Versuche an Drosophila. II. Aktionsbereiche von Drosophila funebris und Drosophila melanogaster. Z. induct. Abstamm.-u. Vererblehre, 79: 35-43.
- TIMOFEEF-RESSOVSKY, N.W., and E.A. (1940c). Populationsgenetische Versuche an Drosophila. III. Quantitative Untersuchung an einigen Drosophila-Populationen. Z. induct. Abstamm.-u. Vererblehre, 79: 44-49.
- TODD, V. (1949) The habits and ecology of the British Harvestmen (Arachnida, Opiliones), with special reference to those of the Oxford district. J. Anim. Ecol., 18: 209-229.
- VILLENEUVE, J. (1921) Description de dipteres nouveaux. Ann. d. 1. Soc. Ent. de Belgique, 61: 157-161.
- WHEELER, M.R. (1949) The subgenus Pholadoris (Drosophila) with descriptions of two new species. Univ. Tex. Pub., 4920: 143-156. (1949)

WIGGLESWORTH, V.B. (1945) Transpiration through the cuticle of Insects. J. exp. Biol., 21: 97-114.

WOLLASTON, T.V. (1858) Brief diagnostic characters of undescribed Madeiran insects. Ann. Mag. nat. Hist., I (3rd): 113-125.

ZETTERSTEDT, J.W. (1847) Diptera Scandinaviae, 6: 2541-2572.
(Lund.).

APPENDIX I

NORFOLK AND SUFFOLK, 1952

DATE	Birches and oak in grassland nr. Mildenhall		Mixed wood with mainly oak, also pine, spruce (between Mildenhall and Thetford)		Pine plantation nr. Thetford		Pond with birch, hawthorn, willow and dense bracken nr. Watton		Wood (A) along Scoulton Mere		Wood (B) along Scoulton Mere		Cow pasture near Scoulton, with hawthorn hedge and oaks		Mr. Barber's garden and orchard, nr. Scoulton		Island in Scoulton Mere with woodland		Ward's farm (cows, pigs, horses) nr. Scoulton		Ward's cow meadow with oaks and pond		Ward's mangle pile	
	APRIL 28,29	AUG. 20,21	APRIL 28,29	AUG. 20-21	APRIL 28,29 MAY 2	AUG. 21,22	MAY 2	AUG. 21,22	MAY 8	AUG. 25,31	MAY 8	AUG. 25,31	MAY 3,4,5,7,9	AUG 28 SEPT. 2.	MAY. 3,4,5,7,8.	SEPT. 1	MAY 3,4,5,7,9	SEPT. 1	MAY 3,4	AUG. 23,24,26.	AUG. 23	MAY. 3,4	SEPT. 2	
subobscura	55.9	87.2	28.5	48.5	22.6	93.2	25.4	77.5	87.8	54.6	84.6	53.6	73.9	82.7	64.0	45.0	14.8	70.1	9.5	0.8	62.9	60%	90.	
obscura	16.7	5.2	24.4	15.2	41.4	4.8	1.5	3.5	5.6	9.7	3.3	12.9	17.4	2.7	13.1	2.1	23.8	9.2	14.3	13.7				
tristis	9.5	4.1	8.1	6.5	4.7	1.1	3.0	12.1	4.4	15.2	1.8	13.8		4.0	9.8	3.5	15.8	4.8		10.7				
ambigua				0.8																				
obscura-X										0.4		0.3												
deflexa						0.2	1.5			5.1		3.4		1.3		11.3		6.8			0.9			
phalerata	13.1	1.1	26.2	10.4	28.9		25.4	3.5	2.2	10.3	9.2	8.8	4.4	1.3	13.1		25.7	1.0	4.8	3.5	20			
kuntzei			11.3	9.9	1.6					0.7	0.7	1.3					12.9				0.1	20		
transversa	2.4	0.3	0.5				43.3	1.7		0.1							5.0							
melanogaster		0.8						1.7		0.8		0.2		4.0		24.6		5.3	4.8	1.6	0.1	9.		
busckii								1.7		0.3		0.3		1.3		9.2		1.5		35.2	1.7			
funebria				8.5	0.8					0.3		1.3	4.4	2.7		4.2		1.5	66.6	60.2	6.0			
hydei										1.0										0.5				
immigrans																				1.6				
histrionic	2.4											3.6												
cameraria		1.1		0.3						0.3		0.2									0.3			
vibrissina			0.5							0.1							2.0							
littoralis										0.1														
other Drosophilids		0.3	0.5			0.7				0.1	0.4	0.3												
TOTAL NO. FLIES	84	366	221	355	128	435	67	8	320	710	373	937	23	75	61	142	101	207	21	364	720	5	31	

UG 28 EPT. 2.	MAY. 3,4,5,7,8.	SEPT. 1	MAY 3,4,5,7,9	SEPT. 1	MAY 3,4	AUG. 23,24,26	AUG. 23	MAY. 3,4	SEPT. 2	MAY 6	AUG. 29	MAY 6	AUG. 29
2.7	64.0	45.0	14.8	70.1	9.5	0.8	62.9	60%	90.4	86.7	86.0	9.9	78.2
2.7	13.1	2.1	23.8	9.2	14.3		13.7			6.7	2.7	4.4	4.8
4.0	9.8	3.5	15.8	4.8			10.7			6.7	2.0	2.2	1.2
		11.3		6.8			0.9						
	13.1		25.7	1.0	4.8		3.5	20			0.7	69.3	0.6
			12.9				1.3				1.3	2.2	0.6
			5.0				0.1	20			2.2		
4.0		24.6		5.3	4.8	1.6	0.1		9.7				3.7
1.3		9.2		1.5		35.2	1.7				2.7		4.2
2.7		4.2		1.5	66.6	60.2	6.0				2.7		4.8
						0.5					1.3		1.8
						1.6							
			2.0				0.3				0.7	2.2	
												3.3	
												2.2	
75	61	142	101	207	21	364	720	5	31	45	149	91	15

MAY 6	AUG. 29	MAY 6	AUG. 30	MAY 6	AUG. 30	AUG. 26	APRIL 30 MAY 1	AUG. 26	APRIL 30 MAY 1	AUG. 26	JUNE 1-3	JUNE 4	JUNE 4
100%	96.8	90.9	95.7	88.0	81.0	75%	61.9	85.5	64.2	79.5	97.5	90.9	91.3
		9.1		6.0	0.9		16.9	4.5	14.3	1.3	0.3	6.9	3.8
			1.4	1.2	1.7		4.8	4.7	7.1	0.7		0.6	2.5
										0.7			
				3.6	10.3		4.8	2.7	14.3	1.3			1.7
				1.2	0.9		7.2	1.5		6.0			
			2.9		0.9	25%	2.4	0.4		8.6	0.6	0.6	0.8
					3.4			1.5		2.0	3.1		
								0.7			0.3		
					0.9			0.4					
2	64	11	70	83	116	12	42	268	14	151	328	348	239

and oaks

Mr Barber's garden
and orchard,
Mr. Scoulton

Island in Scoulton
Here with woodland

Ward's farm (cows,
pigs, horses)
Nr. Scoulton

Ward's cow meadow
with oaks and
pond

Ward's mangle
pile

Ward's wheatfield

Wood of large
pines with burnt
undergrowth
near Sundringham

Pine and birch
wood near
Sandringham

Heath near
Sandringham

Fenland drainage
ditch near
Downham Market

Fenland sycamore
wood near
Downham Market

Beach near Yarmouth

Swampy meadow near
with willow and
hawthorn

Rushes and swampy
wood with oak
and willow near
Filby Broad

Wicken Fen, Cambs.

Chippenham Fen,
Cambs. woodland

Chippenham Fen,
Cambs. open woodland

NEW FOREST (16)
June 14-26, 1952

	Oak and holly: small pond	Heath	Large oaks and beeches	Large pines	Large pines: small pines:	Saplings along stream	Spruce plant- ation near stream	Beech, oak and holly	Cow meadow with stream	Meadow	Scrub along creek	Meadow along Avon	Farm	
subobscura	27.4	91.6	49.1	80.0	74.0	39.8	31.5	29.4	96.5	95.8	61.4	94.9	59.7	
obscura	55.0	8.4	34.0	17.3	21.4	36.2	51.9	18.1	1.7		31.8	5.2	6.4	
tristis	1.6		2.8	1.4	0.7		0.4	0.7			0.3			
ambigua			0.3					2.5	1.0				3.2	
obscura-X	10.6		0.3	0.5	0.3	0.5	1.3	0.5					18.5	
helvetica	1.6		7.2		0.7	2.7	1.7	20.8			0.2			
deflexa	2.0		0.8			0.5	8.8	7.4			5.6		1.4	
phalerata			1.4	0.5	0.7	9.6	8.8	16.9	0.3	4.2			0.7	
kuntzii	1.6		1.4		1.0	8.3	18.5							
traversa														
funeraria								2.7						
melanogaster														
buseckii														
hydel														
immigrans	0.4		2.5	0.5	1.3	2.4	5.0	0.5			0.9		8.9	
histrion													1.1	
caneraria														
vibrissina							0.8							
other Drosophilids									0.3					
TOTAL	255	250	361	214	308	218	238	403	287	58	48	574	58	281

WELLS, SOMERSET (21)
July 22-24, 1952

TINTAGEL,
CORNWALL (20)
July 26, 27,
1952

OTTERHAM,
CORNWALL (19)
July 28-30,
1952

BRENTMOOR, DEVON (18)
August 4-6, 1952

SALCOMBE, DEVON (17)
August 7-10, 1952

	Coniferous wood	Open hillside	Open hillside with gorse	Deciduous wood	Wooded stream	Open stream	Cliff: no trees	Meadow	Farm	Wood along stream	Covered moor	Open moor	Open stream	Wooded stream	Planted woody garden: pine, cyprus, bamboo, etc.	Bamboo, hydrangea, sycamore, palm	Greenhouse	Farm	Oak woods	Bracken
<i>subobscura</i>	50.6	99.0	100	61.8	53.9	78.9	83.3	100%	60.1	51.7	97.0	96.5	83.6	63.9	33.2	24.2	58.2	68.2	32.8	98.8
<i>obscura</i>	31.0			23.5	19.5				14.0	6.2	2.6	2.1	13.5	20.2	41.5	56.8	32.8	16.3	0.1	
<i>tristis</i>	7.1			6.9					4.8	.8	0.2	0.7	2.3	6.9	3.8	4.0	1.3	2.8	13.3	
<i>ambigua</i>	1.2			1.2	0.3				0.7				0.7	0.2			1.3			
<i>obscura-X</i>	1.5			0.2					0.3											
<i>helvetica</i>					1.8				3.8	.8						0.7		2.0	1.7	
<i>deflexa</i>	2.9			2.5					0.3			0.7			1.1	0.4		0.9		
<i>phalerata</i>	2.0			1.2	23.3				4.1	32.8			2.0	3.8	17.7	11.0	1.3	5.3	6.1	1.2
<i>kuntzii</i>															0.3			0.6		
<i>funebria</i>	2.0			0.2	0.7	11.0			11.9				0.2	0.7	1.3	0.4	5.1	3.1		
<i>melanogaster</i>							5.6													
<i>immigrans</i>					0.5															
<i>forcipata</i>						5.0														
<i>histrion</i>															0.8	1.1		0.6		
<i>cameraria</i>	1.8			1.4						2.2	2.0			4.4	0.8	1.5		0.2		
<i>vibrissina</i>															0.3					
other <i>Drosophilids</i>		1.0				5.0	11.1													
TOTAL NO.	1076	210	270	597	399	19	54	48	293	569	338	111	429	550	371	273	79	55	294	83

Appendix I Collections made during the summers of 1952 and 1953, showing the percentage of each species caught at each locality. The number in parentheses after a locality indicates its location on the map, fig. III-3.

OXFORD, 1952

DATE	Marley: cow pasture with birch and hawthorn scrub	Marley: scrub wood: hawthorn, birch	Wytham woods near chalet.	Garden and fruit trees at Hearstrise Road, Oxford	Garden and fruit trees at Hearstrise Road, Oxford	Garden and fruit trees at Hearstrise Road, Oxford	May's farm, Wytham village, with cows and pigs	May's farm, Wytham village, with cows and pigs	May's farm, Wytham village, with cows and pigs	May's farm, Wytham village, with cows and pigs	Meadow near Wytham along small river with willows on the banks	Meadow near Wytham along small river with willows on the banks	Meadow near Wytham along small river with willows on the banks	Garden with small trees, Museum Road, Oxford	Garden with small trees, Museum Road, Oxford	Garden with small trees, Museum Road, Oxford	Wytham woods A: sycamore wood	Wytham woods A: sycamore wood	Wytham woods B: fir wood	Wytham woods B: fir wood
	APRIL 17, 24, 25	APRIL 17, 24, 25	MAY 28, 29	MAY 18, 21	AUGUST 13	SEPT. 19, 21	APRIL 24, 25	MAY 21, 22	AUG. 12, 14	SEPT. 18, 19	MAY 21, 22	AUG. 12, 14	SEPT. 18, 19	MAY 15-21	JULY 21	AUG. 23, 24	JULY 17	JULY 19	JULY 17	JULY 19
<i>subobscura</i>	45%	43.6%	82.6%	83.6%	89.2%	94.3%	66.7	75.5%	35.4%	63.7%	89.5%	74.5%	80.0%	89.6%	29.6%	93.9%	25.4%	20.3%	57.2%	50.8%
<i>obscura</i>	35.3%	23.0%	15.9%	3.8%	4.5%	2.3%	33.3%	1.4%	2.0%		9.8%	18.6%	20.0%	6.0%	33.0%	2.5%	42.9%	30.6%	25.1%	26.3%
<i>tristis</i>	2.0%	2.6%		0.7%	0.5%						0.4%	3.9%					2.1%	6.0%	0.8%	2.8%
<i>ambigua</i>				0.4%	1.7%				0.2%					0.7%	3.1%					0.1%
<i>obscura-X</i>			1.6%																	
<i>deflexa</i>				0.2%													0.2%	1.2%	0.2%	0.4%
<i>phalerata</i>	7.8%	17.9%			0.5%				0.7%					0.4%	0.9%	26.9%	35.6%	11.2%	10.5%	
<i>kuntzei</i>														0.4%			3.2%	1.2%	2.2%	
<i>limbata</i>	5.9%																1.4%	0.2%	0.6%	
<i>traversa</i>	2.0%	12.8%										1.0%								
<i>melanogaster</i>				2.7%	1.7%			2.8%	25.6%	8.3%				1.5%	30.9%	2.5%	0.9%	0.2%		
<i>busckii</i>								0.7%	0.5%	2.8%				1.9%	2.6%	1.2%	1.5%	0.5%	0.2%	
<i>funebis</i>				8.7%	1.7%	3.5%		19.6%	34.9%	25.0%	0.4%						0.2%	0.4%		
<i>immigrans</i>									0.5%											
<i>cameraria</i>																			3.9%	6.3%
other Drosophilids	2.0%											2.0%								
TOTAL NO. FLIES	51	39	63	449	176	86	3	143	410	36	256	102	5	268	230	162	468	565	516	826

BAGLEY WOOD, BERKS, 1953

I. Dark wood of Norway spruce (fig. III-17a) II. Small Norway spruce (fig. III-17b) III. Sycamore wood (fig. III-17c) IV. Mixed wood

	May 15-18	June 12-14	July 7	Aug. 2	Sept. 8-9	Nov. 7-8	May 15-19	June 12-14	July 7	Aug. 2	Sept. 9-10	May 15-19	June 12-14	July 7	Aug. 2	Sept. 8-10	May 15-19	June 12-14
subobscura	70.0	51.8	26.8	44.6	80.6	83.4	66.7	71.2	66.7	58.5	84.2	79.6%	29.7	36.4	35.8	70.7	68.6	39.1
obscura	21.5	33.3	47.8	43.5	7.0	9.0	13.3	22.7	20.8	26.8	4.5	8.2%	33.1	32.0	37.5	6.6	17.1	27.8
tristis	6.5	2.3	0.5	1.6	1.6	3.2	6.7			2.4	4.5	2.0	2.5	3.9	4.2	3.6	2.9	3.5
ambigua																		
Obscura-X		4.6			2.1	1.4		3.0				2.0	26.4		3.3	10.9	1.4	14.8
deflexa		3.0	16.1	9.1	1.2			1.5	4.2	2.4			6.6	22.8	18.3	2.9		12.2
phalerata		2.0	2.4	0.5	5.4				4.2	2.4	4.5	4.1	0.8	2.4	0.8	2.2	2.9	
kuntzei	2.0	3.0	6.3		1.6	1.8	6.7			2.4		2.0	0.8	1.5		2.9	7.1	
transversa							6.7			2.4								
limbata								1.5										
melanogaster				0.5														2.6
funebis						0.3								0.5				
repleta					0.4					2.4		2.0						
cameraria																		
vibrissina						0.9												
other Dro-sophilids									4.2					0.5				
TOTAL NO. OF FLIES	153	303	205	186	243	343	15	66	24	41	44	49	121	206	120	137	70	115

BAGLEY WOOD, BERKS, 1953

I. Norway spruce (fig. III-17a)

II. Small Norway spruce (fig. III-17b)

III. Sycamore wood (fig. III-17c)

IV. Mixed wood (fig. III-17d)

V. Fir wood (Fig. III-17e)

VI. Oak wood (Fig. III-17f)

July 7	Aug. 2	sept. 8-9	Nov. 7-8	May 15-19	June 12-14	July 7	Aug. 2	sept. 9-10	May 15-19	June 12-14	July 7	Aug. 2	sept. 8-10	May 15-19	June 12-14	July 7	Aug. 2	sept. 8-10	May 18-19	June 12-14	July 7	Aug. 2	sept. 8-10	May 18-19	June 12-14	July 7	Aug. 2	sept. 8-10	
26.8	44.6	80.6	83.4	66.7	71.2	66.7	58.5	84.2	79.6	29.7	36.4	35.8	70.7	68.6	39.1	37.9	37.8	67.8	52.4	31.7	30.9	23.7	56.8	47.1	15.0	10.8	17.9	64.6	
47.8	43.5	7.0	9.0	13.3	22.7	20.8	26.8	4.5	8.2	33.1	32.0	37.5	6.6	17.1	27.8	32.4	43.0	7.9	33.3	34.2	28.5	42.0	46	11.8	30.1	25.4	32.9	5.1	
0.5	1.6	1.6	3.2	6.7			2.4	4.5	2.0	2.5	3.9	4.2	3.6	2.9	3.5	4.5	3.3	0.7		0.6	0.5	0.5	17		0.9	4.7	4.2	2.2	
		2.1	1.4		3.0				2.0	26.4	22.8	3.3	10.9	14	14.8	0.6	1.4	12.9	4.8	23.2	1.0	2.7	75		30.1	0.8	5.0	7.4	
16.1	9.1	1.2			1.5	4.2	2.4	4.5	4.1	0.8	2.4	0.8	2.2	29	12.2	14.0	14.0	4.3		4.9	34.2	27.4	12	17.6	23.9	53.0	37.5	2.9	
2.4	0.5	5.4	1.8	6.7		4.2	2.4		2.0	0.8	1.5		2.9	71		7.3		2.8	9.5	2.4	2.9	2.3	20.3	23.5	4.7	1.3	10.3	7.4	
6.3		1.6		6.7			2.4						2.9			1.7		2.8		1.8	1.0	0.9	75				1.3		
	0.5		0.3	6.7	1.5		2.4	2.3			0.5				2.6	0.6	0.5				0.5	0.5	0.6				0.8		
		0.4	0.9						2.0												0.6			0.6					
						4.2					0.5																		
205	186	243	343	15	66	24	41	44	49	121	206	120	137	70	115	179	214	140	21	164	210	219	174	17	113	130	240	136	

GARDENS IN OXFORD, 1953

	Small garden in housing development South of Oxford						Large garden near meadow: North Oxford					
	May 4	June 1-5	July 1	Aug. 1	Sept. 6	Oct. 19-20	Nov. 27-28	May 6-7	June 11-12	July 2	Aug. 3	Sept. 10
subobscura	100%	95.2	88.9	67.5	59.3	75.5	87.0	90.2	93.8	53.7	79.2	74.6
obscura			3.4	14.7	15.1			2.7	2.6	3.9	3.6	6.6
tristis					0.9			1.1	0.3			0.8
ambigua			1.7	0.6	2.6	0.7		2.7	0.7	2.4		4.9
Obscura-X												1.6
deflexa			3.9	1.2						0.5	1.0	
phalerata											2.0	
kuntzei						1.3		0.5				1.6
transversa							2.6	1.1				
limbata								0.5				
melanogaster		4.8	1.7	11.7	19.3	15.9		2.0	39.0	9.7	8.3	
funebria			0.6	2.5	2.2	4.6		0.5	0.7	0.5		0.8
busckii					0.4		2.6				4.1	0.8
hydei				1.8		2.0	6.5					
immigrans								0.5				
cameraria												
rufifrons							1.3					
other Dro-sophilids											0.5	
TOTAL NO. OF FLIES	4	146	179	163	228	151	77	183	305	205	197	122

MOIST SCRUB, WOODLANDS AND MEADOWS NEAR OXFORD, 1953

MARLEY WOOD, BERKS

COTHILL, BERKS

	SCRUB WOODLAND IN MEADOW WITH STREAM					BOG WITH BRACKEN AND SCRUB					MEADOW		SCRUB WOODLAND		BOG WITH REEDS		SWAMPY WOOD	
	May 11-14	June 3-5	July 4	Aug. 1	Sept. 14-15	May 11-14	June 3-5	July 4	Aug. 1	Sept. 14-15	May 20-21	July 8	May 20-21	July 8	May 20-21	July 8	May 20-21	July 8
<i>subobscura</i>	75.0	89.6	65.8	56.8	65.6	77.3	97.5	81.1	65.2	88.0	89.7	96.8	75.5	32.6	100%	85.7	70.5	32.7
<i>obscura</i>	12.5	8.3	17.4	29.9	13.1	9.1	2.6	12.7	23.9				10.6	21.7		3.1	8.7	26.7
<i>tristis</i>	5.4	0.7	2.7	5.4	4.9	4.5			4.4				6.4	10.3			15.4	14.0
<i>ambigua</i>						4.5								3.8		2.0		0.7
<i>Obscura-X</i>					1.6	4.5							1.1					
<i>deflexa</i>			7.1	1.8				1.3	6.5							2.0		21.3
<i>phalerata</i>	3.6		5.4	3.0	13.1			3.8		4.0			5.3	25.5				2.0
<i>kuntzei</i>	3.6		0.5							8.0				1.1		2.7		2.0
<i>transversa</i>				0.6							7.4			0.5				0.7
<i>melanogaster</i>		0.7	0.5	1.2							2.9	3.2		8.8				2.0
<i>funbris</i>			0.5	0.6										0.5		7.1		
<i>hydei</i>																		
<i>caneraria</i>				0.6	1.6			1.3										
<i>littoralis</i>																		
<i>rufifrons</i>		0.7											1.1				2.7	
TOTAL NO. OF FLIES	56	144	184	167	61	22	39	79	46	25	68	93	94	184	8	98	149	150

KENT AND SUSSEX: JUNE 17 - 24, 1953

	Cherry orchard, Wye	Beechwood on Downs Wye	Strawberry Patch, Wye	Shed, Wye	Old beech wood, Horsham	Old mixed wood, Horsham	Young scrub wood along stream, Horsham	Hawthorn copse on downs near Washington	Open downs near Washington
<i>subobscura</i>	31.3	61.0	34.0		37.3	35.8	30.2	28.0	71.4
<i>obscura</i>	16.9	23.3			19.0	21.2	25.2	15.0	
<i>tristis</i>					1.2	3.7	0.9	3.0	
<i>ambigua</i>	8.9	4.1	0.7		0.3				
<i>obscura-X</i>					5.2	7.1	3.4		
<i>helvetica</i>		3.4			0.9	1.4	0.3		
<i>deflexa</i>	1.7				18.7	8.6	11.8	8.0	
<i>phalerata</i>					5.8	8.0	16.8	6.0	
<i>kuntzei</i>					8.6	10.6	8.1	1.0	
<i>melanogaster</i>	37.1	6.8	63.9	100%	0.3		0.6	5.0	28.6
<i>funebria</i>	1.1	1.4			2.4	2.0	0.9	33.0	
<i>hydei</i>	3.0		1.3						
<i>immigrans</i>								1.0	
<i>histrion</i>					0.3	1.4	1.2		
<i>vibrissina</i>									
<i>cameraria</i>									
<i>littoralis</i>							0.3		
other Drosophilids									
TOTAL NO. FLIES	361	146	582	30	327	349	321	100	70

GLOUCESTERSHIRE, MONMOUTHSHIRE AND HEREFORDSHIRE, JULY 20 - 27, 1953

	Garden: Stinchcombe nr. Dursley, Glos.	Orchard: Stinchcombe nr Dursley, Glos.	Old beech woodland nr. Dursley, Glos. (on steep hill)	Open wood of large oaks, Forest of Dean, Glos.	Young larch plant- ation, Forest of Dean, Glos.	Dense plantation of beech and oak, Forest of Dean, Glos.	Bracken on hillside, Forest of Dean, Glos.	Open wood with large trees near Symond's Yat, Glos.	Grove of small trees with pond in pasture near Monmouth	Grove of tall oaks near Hardsley, Herefordshire	Cellar of pub., Hardsley
subobscura	39.5	56.4	29.6	57.6	76.2	64.1	94.1	78.1	38.9	46.6	
obscura	10.8	21.3	50.4	27.6	16.8	22.9	3.6	14.6	24.8	36.6	
tristis	2.6	7.8	5.4	2.4				2.0	12.7	12.1	
ambigua	3.6	4.3	7.5	2.0		0.8	0.7		0.6		3.2
obscura-X			0.4	2.0		0.8		1.3	0.6	0.4	
helvetica	2.1	1.1		4.4		9.9		2.0	1.9	0.9	
deflexa	1.0	1.1	2.1	9.7					5.7	3.9	
phalerata		2.1	2.9	1.7	3.0	0.8		1.3	9.6	1.7	
kuntzei			0.8								
transversa				1.0			1.5		0.6		64.5
melanogaster	17.4	5.3		0.3		0.8		0.7	3.2	0.4	32.3
funebria	23.1	1.1	0.8								
hydei											
immigrans				0.3	3.0				0.6		
cameraria					1.0						
histrion					1.0						
vibrissina					1.0						
other Drosophilids											
TOTAL NO. FLIES	195	94	240	297	101	131	137	151	157	223	31

APPENDIX II

NOTE: b = busckii; c = cameraria; v = vibrissina; f = funebria

m = melanogaster; i = immigrans; tr. = transversa; y = littoralis

u, z = other Drosophilids

All collections (except those noted) made with 10 cups/locality

All temperatures given in °C.

TIME TEMP HUMID LIGHT WIND AND WEATHER

WYTHAM A, BERKS.
 JULY 17, 1952
 ALL-DAY COLLECTION

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	SUB. OBS.	OBSC.	OTHERS	PHAL.	QUINARIA-GROUP	DEFLEXA	OTHERS
3:55-	12.7	85%	0.3-	-	-	-	-	-	-	-	-
4:10			0.8								
4:55-	12.6	86%	1.6-	occasional sprinkles	-	-	-	-	-	-	-
5:10			3.2	and misty rain							
6:05-	13.5	85%	6.5	completely overcast	2	1	4	3	lt	--	11 2m
6:25											
7:00-	14.1	83%	6.5	completely overcast	2	1	3	1	lt	--	6 1m
7:15											
8:25-	15.5	80%	25	10 min. rainy pd: did not reach forest floor	5	1	8	2	--	--	10 17
8:50				still overcast	-	4	8	8	lt	--	8 12
9:55											
10:55-	17.8	73%	50+	still overcast	1	3	6	6	--	--	9 17 1m
11:20											
12:15-	17.5	75%	17	still overcast	-	4	16	4	lt	--	2 3
12:35											
1:35-	17.5	75%	50-	-	3	3	13	11	IX	--	5
1:55											
2:55-	18.7	73%	60	blue sky	1	9	9	5	--	--	3 3
3:10											
4:15-	19.5	70%	30-	blue sky and sun out	3	7	17	11	lt	lt	2 2
4:30			75								
5:45-	18.2	70%	13	-	9	21	22	8	--	--	6 3 1f
6:10											
7:15-	17.2	76%	4.0	-	20	17	18	13	3t	--	13 4 1f 5f
7:35											
8:35-	15.8	80%	0.2	-	-	1	3	1	--	--	-
8:55											

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUINARIA-GROUP		DEFIE XA OTHERS	
					SUB. OBS.	OTHERS	PHAL.	KUNTZ	δ ♀	δ ♀
WYTHAM B, BERKS										
JULY 17, 1952 ALL-DAY COLLECTION										
4:10-	13.2	77%	0.6	-	-	-	-	-	-	-
4:25				occasional sprinkles	1	3	4	-	-	9c 4c
5:10-	13.5	85%	2.0	-	7	15	2	1	-	2c 3c
5:25				completely overcast						
6:25-	14.4	85%	4.0	-	5	10	2	1	1t	-
6:45				completely overcast						
7:20-	14.8	81%	10-	-						
7:40				10 min. rainy pd.: didn't reach forest floor	11	15	11	1	1t	5 4
8:55-	15.5	78%	25	-	7	4	2	1	-	2 3
9:15				sun came out briefly						
10:00-	16.7	76%	25-	-	10	9	5	1	-	3 3
10:20				overcast again						
11:20-	16.8	77%	10	very still	11	15	10	2	-	2 3
11:50				overcast: still						
12:35-	17.2	74%	6.5	-	2	11	8	6	1x	2
1:10				blue sky						
1:55-	17.2	76%	13	-	10	25	11	9	-	3
2:15				blue sky and sun out						
3:25-	19.0	78%	30	-	8	21	8	10	-	4 2
3:45				blue sky and sun out						
4:30-	19.6	68%	25-	-	18	61	15	5	1t	13 3
4:45				-						{ 1c 1f
6:10-	19.5	72%	4.0	-	11	5	15	1	-	2
6:25				-						
7:35-	17.0	78%	0.8	-						
7:55				-						
8:25-	16.5	83%	0.4	-						
8:35				-						

TIME TEMP HUMID LIGHT WIND AND WEATHER
 WYTHAM A, BERKS
 ALL-DAY COLLECTION

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP SUB. OBSC. OTHERS	QUINARIA-GROUP PHAL. KUNTZ.	DEFLEKA	OTHERS
warm, cloudy night:								
at 4:00, clouds broke: beautiful warm day								
3:50-	15.3	82%	0.4-	-	-	-	-	-
4:05			0.8	-	-	-	-	-
4:35	15.5	83%	2.0	-	activity beginning but no collection made	-	-	-
5:05-	14.7	90%	6.5	wind began in tree tops	4 9 4 -- --	3	-	3 11
5:25								
6:35-	16.8	79%	8.0-	-	5 1 18 12 2t --	- 1	-	18 15 - 1f
6:55			13.0					
8:00-	18.7	72%	50	large clouds w th	7 1 9 - 7t 2t	-	-	16 16 -
8:20				occasional blue				
9:20-	19.3	68%	75	-	3 1 9 2 2t --	1	-	7 3 -
9:45								
10:50-	19.6	66%	75-	blue w th occasional	- - 4 2 1t --	-	-	2 4 -
11:05			100	clouds				
12:5 0-	22.5	62%	50-	cloudier again	8 2 14 5 4t --	-	1	9 6 -
1:05			100					
2:20-	22.0	61%	25	-	5 1 12 9 {3t 2X	-	-	5 2 -
2:40								
4:00-	21.0	66%	25	-	6 6 13 11 {1t 1X 2X	-	-	6 10 -
4:15								
5:20-	22.0	67%	15	-	8 6 16 13 2t --	-	1	13 4 -
5:30								
6:55-	20.8	73%	4.0	-	24 15 12 3 {1t 1X	5 2	4 1	26 11 1f 1f
7:10								
8:00-	18.7	75%	1.0	-	7 2 5 2 6t --	4 2	1 -	8 17 - 1f
8:10								
8:55-	18.6	77%	0.2	-	- - - - -	-	-	- - -
9:05								

TIME TEMP HUMID LIGHT WIND AND WEATHER OBSCURA--GROUP QUINARIA--GROUP DEFLEXA OTHERS
 SUB. OBSC. OTHERS PHAL. KUNTZ.

WYTHAM B, BERKS ALL-DAY COLLECTION ON

JULY 19, 1952 WARM CLOUDY NIGHT: AT 4:00 CLOUDS BROKE AND DAY BECAME BEAUTIFUL, WARM AND CLEAR

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA--GROUP	QUINARIA--GROUP	DEFLEXA	OTHERS
					SUB. OBSC. OTHERS	PHAL. KUNTZ.		
4:20-	15.3	75%	0.8 ⁺	-	8 2 4 3	- - -	- - -	- - -
4:35								
5:30-	15.3	82%	3.2	-	19 16 9 5 5t	- - -	6 2 -	2 - 29c 7c
6:00								
6:55-	16.8	83%	6.5	-	23 24 9 8 2t	- - -	1 2 -	3 2 11c 4c
7:20				clouds w th occasional blue				
8:25-	18.3	65%	13-	-	19 20 12 8 5t	- - -	2 - -	7 7 - -
8:40			150					
9:50-	19.0	70%		-	10 10 3 2	- - -	1 1 -	1 3 - -
10:05				blue w th occasional clouds				
11:05-	20.0	64%	50-	sun out	6 9 13 8 2t	- - -	- - -	8 4 - -
11:25			400	cloudier again				
1:10-	21.5	63%	25	-	17 16 33 8 4t	- - -	- - -	2 3 - -
1:35								
2:10-	20.5	69%	15-	-	18 34 17 9 2t	- - -	- - -	4 3 - -
3:00			20					
4:15-	21.0	70%	8.0	-	27 34 10 16 1X	- - -	1 2 -	8 9 - -
4:35								
5:30-	22.2	70%	6.5	-	14 13 6 1 2X	- - -	- - -	5 4 - -
5:45								
7:10-	21.3	73%	3.2	-	32 28 16 5 { 2t	- - -	4 3 -	8 1 - 1u
7:25					1a			
8:15-	19.7	73%	0.4	-	7 14 8 4 1t	- - -	- 2 -	1 2 1c -
8:30								
9:05	18.6	76%	0.2	-	- - - - -	- - -	- - -	- - -

TIME	TEMP	HUMID	LIGHT	WIND	AND WEATHER	OBSCURA-GROUP				QUINARIA-GROUP				DEFIE XA		OTHERS	
						SUB.	OBSC.	OTHERS		PHAL.	KUNTZ.						
						♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
SCOULTONA, NORFOLK																	
AUGUST 24, 1952 ALL-DAY COLLECTION																	
4:20	13.3	95%	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5:30	12.5	92%	2.0	-	-	12	5	5	3	6t	3t	1	-	-	-	-	-
7:05	15.8	85%	25	-	-	?	7	7	2	6t	3t	4	2	-	-	1	-
8:40	18.1	77%	50- 250	-	-	9	1	1	-	1t	--	-	-	-	-	-	-
10:10	18.5	71%	75	-	-	-	1	1	-	1t	--	-	-	-	-	-	1b
11:50	19.6	68%	100	-	clouding over: no direct sun	5	5	-	-	3t	--	1	-	-	-	-	-
1:40	19.7	72%	50	-	-	7	8	1	-	2t	--	-	2	-	-	-	-
2:20	19.19	71%	50	-	still clouded over	8	4	3	2	5t	--	4	1	-	-	-	-
4:45	19.0	70%	15	-	-	25	13	1	3	{4t 1X	2t --	{6 1 tr. 18	2 5 5	1 ♂ 1	- - 2	1 - 2	- - 2
6:30	17.8	79%	2.0	-	-	1	18	1	5	{12t 1X	7t --	-	-	-	-	-	-
7:45	16.8	84%	0.4	-	-	-	-	-	-	--	--	-	-	-	-	-	-

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP				QUINARIA-GROUP				DEFLEXA	OTHERS	
					SUB.	OBSC.	OTHERS	OTHERS	PHAL	KUNTZ.	δ	♀			
SCOULTON A, NORFOLK ALL-DAY COLLECTION															
AUGUST 31, 1952															
4:25	15.0	95%	0.2	-	-	-	-	-	-	-	-	-	-	-	-
5:00-	13.3	94%	0.8	-	-	-	-	-	-	-	-	-	-	-	-
5:10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5:10-	13.3	90%	1.6"	very foggy morning	5	2	2	-	2t	-	-	-	-	1	3
5:25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6:15-	14.7	91%	13	-	18	21	15	9	16t	10t	7	3	-	-	-
7:15	15.3	90%	20	-	13	5	-	1	4t	--	2	-	1	1	-
8:30	17.2	85%	100	-	5	1	1	1	1t	--	2	1	-	1	-
9:40	19.3	73%	50-	-	2	2	1	-	--	--	1	1	-	-	6
	1600														
11:05	20.5	70%	100	uniform cloudy	-	-	-	-	--	--	-	-	-	1	1
12:10	21.8	70%	100-	sunny and cloudy intervals	-	1	1	1	1t	--	-	-	-	-	2
	1600														
2:00	20.9	72%	50-	still overcast	-	3	-	-	1t	--	2	1	-	-	1
	150														
3:20	20.5	71%	30	-	3	7	-	-	1t	--	-	1	-	-	3
4:35	20.9	70%	13	-	9	2	-	-	1t	--	1	-	-	-	2
									1X	--					1f
5:50	20.6	70%	13	-	21	5	1	-	3t	1t	-	1	-	-	1
															3
6:50	19.8	72%	3.2	-	24	13	-	-	5t	3t	1	1	-	-	1
															2
7:40	19.2	71%	0.4	-	-	-	-	-	--	--	-	-	-	-	-
															-

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP			QUINARIA-GROUP			DEFLEXA			OTHERS			
					SUB. OBSC. OTHERS			PHAL. KUNTZ									
					δ	γ	δ	δ	γ	δ	γ	δ	γ		δ		
SCOULTON B. NORFOLK																	
AUGUST 31, 1952 ALL-DAY COLLECTION																	
4:25	15.0	95%	0.2	-	-	-	-	-	-	-	-	-	-	-			
5:00	13.3	94%	0.8	-	-	-	-	-	-	-	-	-	-	-			
5:10	13.3	90%	1.6"	very foggy morning	ONLY A COLLECTED: ACTIVITY ALSO BEGINNING IN B												
5:25	14.7	91%	13	-	27	20	18	2	14t	5t	12	3	3	2	1	{ 7c 4c - 2f	
6:15	15.3	90%	20	-	23	6	7	1	15t	--	3	3	--	--	1	{ 4c 2c 2f 1f	
7:15	17.2	85%	100	-	18	5	4	--	4t	--	--	2	--	--	1	-	
9:40	19.3	73%	50- 1600	-	--	--	4	--	1t	2t	1	3	--	2	1	-	
11:05	20.5	70%	100	uniform clouds	--	--	--	--	--	--	--	--	--	--	1	--	
12:10	21.8	70%	100- 1600	cloudy and bright intervals	1	3	1	--	--	--	--	--	--	--	3	1	- 1f
2:00	20.9	72%	50- 150	still overcast	3	2	--	--	2t	--	--	--	--	--	--	--	-
3:20	20.5	71%	30	-	11	10	1	--	1t	--	--	2	--	--	1	--	-
4:35	20.9	70%	13	-	15	4	--	--	--	--	1	4	--	2	3	--	-
5:50	20.6	70%	13	-	19	5	4	1	--	1t	4	2	1	--	1	1	-
6:50	19.8	72%	3.2	-	40	8	1	4	2t	--	2	4	1	1	1	3	{ 3c 3c 2f 1f - 1b 1m 5m
7:40	19.2	71%	0.4	-	--	--	--	--	--	--	--	--	--	--	--	--	-

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUITARIA-GROUP		DEFLEXA		OTHERS	
					SUB.	OTHERS.	PHAL.	KUNTZ.	♂	♀	♂	♀
WYTHAM C, BERKS												
AUGUST 10, 1953 ALL-DAY COLLECTION												
3:45	{ 15.5	90%	0.8									
	{ 13.9											
4:10	{ 14.0	90%	0.8	wind: 78 ft./min.								
	{ 11.8											
4:45	{ 12.8	90%	6.5	wind: 68 ft./min.	7	4						1m
	{ 12.2											
6:15	{ 14.8	84%	100-	wind: 80 ft./min.	20	30						
	{ 13.8		800	cloudless day: shadows long								
7:45	{ 17.2	71%	600-	wind: 50 ft./min.		6						
	{ 15.8		1600+									
9:05	{ 27.2	56%	400-	wind: 103 ft./min.								
	{ 21.2		1500+	cloudless day								
10:20	{ 25.2	47%	1600+	wind: 70 ft./min.								1m
	{ 24.4			very little shade								
11:40	{ 19.9	53%	400	wind: 75 ft./min.		6						
	{ 22.9			lots of clouds								
1:00	{ 30.0	58%	1600+	wind: 175 ft./min.		3						
	{ 26.5		some large, fluffy clouds									
2:25	{ 24.9	58%	1600+	wind: 50 ft./min.								
	{ 26.0			no clouds								
3:45	{ 27.1	49%	400-	wind: 72 ft./min.		3						
	{ 27.5		1600	shadows lengthening								
5:15	{ 20.5	52%	400-	wind: 40 ft./min.		1	11					
	{ 25.5		800									
6:45	{ 18.8	73%	50-	wind: 69 ft./min.		9	97					2m 1m
	{ 17.2		100									
8:15	{ 15.2	77%	0.8-									
	{ 13.5											

* Upper temperature: ground temperature
 Lower temperature: air temperature

Note: 20 cups used in collection.

QUINARIA-GROUP DEFLEXA OTHERS
PHAL. KUNTZ.

OBSCURA-GROUP
GUB. OBSC. OTHERS

WIND AND WEATHER

TIME TEMP HUMID LIGHT

WYTHAM A, BERKS
AFTERNOON COLLECTION

JULY 10, 1953

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP GUB. OBSC. OTHERS	QUINARIA-GROUP PHAL. KUNTZ.	DEFLEXA	OTHERS
1:10	17.2	66%	13	Day very overcast and humid no wind: overcast high clouds: brightening	4 5 6 1 {lt -- -- IX	1 - - -	1 2 -	1f
2:20	19.2	57%	10-25	sky brightening wind 20 ft./min.	4 1 8 3 lt --	- - - -	7 9 -	lv
3:35	18.4	56%	10-25	no wind	4 2 6 1 -- --	- - - -	5 3 lv -	-
5:00	18.9	80%	13	no wind: only a few clouds	12 14 6 1 lt --	- 1 - -	3 4 -	-
6:10	19.1	81%	6.5	no wind	19 22 5 - lt --	1 2 - -	3 3 -	1f
7:10	16.7	69%	1.6	wind: 22 ft./min.	6 9 2 2 -- --	3 5 - -	5 4	{ - 2f - 1c
8:10	14.8	80%	0.6	no wind	1 - - - -- --	- - - -	1 -	1f 1f

No flies at 9:15

* TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUITNARIA-GROUP		DEFLEXA		OTHERS	
					SUB.	OESC.	OTHERS	PHAL.	KUNTZ.	OTHERS	OTHERS	
WYTHAM C, BERKS AFTERNOON COLLECTION												
JULY 10, 1953												
** 1:25	{ 20.5	55%	800	Day very overcast and humid wind: 125 ft./min.	-	2	-	-	-	-	-	-
	{ 21.3			gentle and steady	-		-	-	-	-	-	-
2:35	{ 21.2	55%	800	wind: 235 ft./min.	-		-	-	-	-	-	-
	{ 20.5				-		-	-	-	-	-	-
3:40	{ 22.6	59%	1600 ⁺	wind: 60 ft./min.	-	2	-	-	-	-	-	-
	{ 22.6			bright sunlight	-		-	-	-	-	-	-
5:10	{ 22.1	60%	1600 ⁺	wind: 112 ft./min.	-	3	-	-	-	-	-	-
	{ 21.5			only few clouds.	-		-	-	-	-	-	-
6:30	{ 18.9	59%	200-	wind: 72 ft./min.	2	24	-	-	-	-	-	-
	{ 19.2		400				-	-	-	-	-	-
7:30	{ 16.2	77%	30	wind: 65 ft./min.	4	37	-	-	-	-	-	-
	{ 15.8						-	-	-	-	-	-
8:30	{ 14.0	89%	4.0	wind: 74 ft./min.	8	25	-	-	-	-	-	-
	{ 12.3						-	-	-	-	-	-
9:20	{ 12.2	91%	0.4	no wind	-	-	-	-	-	-	-	-
	{ 11.9						-	-	-	-	-	-

* Upper temperature: ground temperature
Lower temperature: air temperature

** 20 cups used for C collection

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUIMARIA GROUP		DEFLE XA	OTHERS										
					SUB.	OBSC.	OTHERS	PHAL.			KUNIZ.									
WYTHAM A, BERKS																				
JULY 29, 1953																				
AFTERNOON COLLECTION																				
3:00	18.2	72%	6.5	no wind	11	25	6	4	--	2	--	--	--	--	--	--	--	--	--	--
4:15	18.1	54%	2.0	no wind	1	21	8	2	1X	--	--	--	--	--	--	--	--	--	--	--
4:45-5:00 rained hard: then stopped																				
5:30	16.5	53%	6.5	no wind	4	15	1	3	--	--	--	--	--	--	1	--	10	--	--	--
6:40	15.5	81%	2.0	no wind	5	5	2	6	--	--	--	--	--	--	1	--	--	--	--	--
8:00	14.8	90%	0.8	no wind	1	--	1	--	--	--	--	--	--	--	--	--	1F	--	--	--
8:10											No flies									
WYTHAM C, BERKS																				
JULY 19, 1953																				
AFTERNOON COLLECTION																				
** 2:50	19.1	69%	4.00	wind:108 ft./min.	1	36	--	1	--	--	--	--	--	--	--	--	--	--	--	1m
4:00	18.7	51%	4.00	wind:175 ft./min.	--	21	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5:10	19.9	56%	1.50	wind:133 ft./min.	10	104	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4:45-5:00 rained hard: then stopped																				
6:35	17.2	64%	1.50	no wind	5	76	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7:50	17.2	78%	4.0	wind:104 ft./min.	15	66	4	3	--	--	--	--	--	--	--	--	--	--	--	--
8:40	15.2	78%	0.8	no wind	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	14.3																			
	14.2																			
	14.0																			

* Top temperature: ground temperature
 Bottom temperature: air temperature
 ** 20 cups used for C collections

TIME TEMP HUMID LIGHT WIND AND WEATHER
 OBSCURA-GROUP
 SUB. OBSC. OTHERS
 δ ♀ δ ♀ δ ♀
 WYTHAM A, BERKS
 AFTERNOON COLLECTION

JULY 30, 1953
 Brighter day than July 29
 sky with large clouds
 wind 38ft./min.
 no wind
 no wind
 no wind
 no wind

QUINARIA-GROUP
 PHAL. KUNTZ.
 δ ♀ δ ♀ δ ♀

3:30	18.8	53%	13-25	9	20	8	3	1X	--	--	--	--	--	--	--	--	--	--	--
4:40	18.7	59%	6.5	5	13	10	5	--	--	--	--	--	--	--	--	--	--	--	--
5:55	16.8	63%	6.5	8	24	4	6	{1t	--	--	--	--	--	--	--	--	--	--	1 - 1v
7:10	15.9	75%	1.0	9	5	1	1	-- 2t	1X	--	--	--	--	--	--	--	--	--	1 - 3f 2f
8:10	15.5	76%	0.8-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

WYTHAM C, BERKS
 AFTERNOON COLLECTION

JULY 30, 1953
 wind:272 ft./min.
 wind:199 ft./min.
 more overcast.
 wind:165 ft./min.
 wind:202 ft./min.
 wind:215 ft./min.

* Upper temperature: groundtemperature
 Lower temperature: air temperature

** 20 cups used for C collections

TIME TEMP HUMID LIGHT WIND AND WEATHER
 QUINARI A-GROUP DEFLEKA OTHERS
 PHAL. KUNTZ.
 δ ♀ δ ♀ δ ♀ δ ♀ δ ♀

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP SUB. OBSC. OTHERS δ ♀ δ ♀ δ ♀	WYTHAM A, BERKS AFTERNOON COLLECTION 1 1 1 6 6 1t --	QUINARI A-GROUP PHAL. KUNTZ. δ ♀ δ ♀ δ ♀ δ ♀ δ ♀	DEFLEKA δ ♀ δ ♀ δ ♀	OTHERS δ ♀ δ ♀ δ ♀
3:15	19.3	80%	6.5-	AUGUST 5, 1953 raining lightly: no wind: bright sun and dark clouds	1 1 1 6 6 1t --	1 1 1	1 1	1 1	1m
4:20	21.5	76%	13.5 ⁺	no wind	1 23 1 6 -- 1x	5 2			
5:35	20.3	72%	5.0	no wind	3 36 11 6 { 2t -- { 1x				
6:35	19.2	75%	3.2	sky clear no wind	8 19 8 4 2a --	4 1			2m 1m
7:40	17.5	90%	1.0	no wind	3 8 3 3 -- 1x	3 1			1f
8:20	17.5	87%	0.8-	no wind	- - - - -				

WYTHAM C, BERKS
 AFTERNOON COLLECTION

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	WYTHAM C, BERKS AFTERNOON COLLECTION - 6 - - - - - - 5 - 1 - - - - -	QUINARI A-GROUP PHAL. KUNTZ. δ ♀ δ ♀ δ ♀ δ ♀ δ ♀	DEFLEKA δ ♀ δ ♀ δ ♀	OTHERS δ ♀ δ ♀ δ ♀
3:00	19.0 { 19.5	84%	300	wind: 223 ft./min. raining lightly	- 6 - - - - -			
4:10	23.2 { 25.3	69%	1600	bright sun and dark clouds	- 5 - 1 - - - - -			
5:20	20.8 { 22.0	67%	300	wind: 100 ft./min. wind: 15 1/4 ft./min.	- 7 - - - - -			
6:25	18.1 { 20.2	73%	150	wind: 129 ft./min. sky clear	- 51 - - - - -	{ 1 tr. δ		1m
7:30	17.8 { 17.8	82%	50	wind: 107 ft./min.	- 55 - - - - -	{ 1 tr. ♀		
8:30	18.0 { 18.0	87%	1.0	wind: 20 ft./min.	8 17 3 - - - - - - 1 - - - - -			1m 1m - 1m xx

* Upper temperature: ground temperature
 Lower temperature: air temperature
 ** 20 cups used in C collections
 x First 10 cups
 xx Second 10 cups

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OESCURA-GROUP		QUINARIA-GROUP		DEFLEXA	OTHERS												
					SUB.	OESC.	PHAL.	KUNTZ														
<p>WYTHAM A, BERKS AUGUST 6, 1953 AFTERNOON COLLECTION</p>																						
<p>SULTRY, STILL, HOT DAY</p>																						
3:15	21.9	75%	6.5	no wind	4	14	19	5	2t	--	--	--	--	--	--	--	--	--	--	--		
4:25	21.3	74%	6.5	wind: 72 ft./min.	8	30	9	7	1t	--	--	2	--	--	--	6	4	10	5	1m	--	
5:35	21.2	78%	6.5 ⁺	wind: 0-72 ft./min. puffy	13	20	6	8	--	--	--	6	--	--	--	1	11	1	11	1	1f	--
6:40	21.0	84%	3.2	no wind	12	15	12	4	1t	--	--	5	--	--	--	--	6	1	6	1	1f	--
7:30	20.5	84%	0.8	no wind	9	5	7	5	1t	--	--	8	2	--	--	--	7	4	8	2	--	--

no flies

8:00

*

TIME TEMP HUMID LIGHT WIND AND WEATHER
 WYTHAM C, BERKS
 AUGUST 6, 1953
 AFTERNOON COLLECTION

				OBSCURA-OROUF	OTHERS	CUTHANIA-OROUF	DEFLEKIA	OTHERS
				SUB. OBSC.	OTHERS	PHAL. KUNTZ.		
				♂ ♀	♂ ♀	♂ ♀	♂ ♀	♂ ♀
**	3:00	{ 23.5	SULTRY, STILL, HOT DAY	- 1	- -	- -	- -	- -
		{ 23.7	wind: 75 ft./min.			tr. - 2		
			sultry, still, hot					
	4:15	{ 22.8	wind: 50 ft./min.	- 29	- -	- -	- -	- -
		{ 21.1	400			tr. - 2		
	5:25	{ 21.8	wind: 75 ft./min.	1 21	1 -	- -	- -	1m -
		{ 22.2	300 clouds breaking up					
	6:30	{ 21.3	wind: 10 ft./min.	12 59	- -	- -	- -	- 2m
		{ 21.2						
	7:40	{ 20.4	wind: 12 ft./min.	27 80	- -	- -	- -	2m 4m
		{ 19.8				tr. 3 2		
x	8:15	19.2	wind: 12 ft./min.	6 6	1 -	- -	- -	- 1m
			Getting dark fast					
x	8:25	19.0	wind: 12 ft./min.	- 3	- -	- -	- -	- 1m
			no wind					
	8:45	18.9	87% very	- 2	- -	- -	- -	- 2m
	8:55	18.9	86% low	- -	- -	- -	- -	- 1m

* Upper temperature: ground temperature
 Lower temperature: air temperature

** 20 cups used in C collections
 x 5 traps collected

TIME	TEMP	HUMID LIGHT	WIND AND WEATHER	OBSCURA-GROUP SUB. OBSC. OTHERS	QUINARIA-GROUP PHAL. KUNTZ.	OTHERS
6:45	7.8	-		♂ ♀ ♂ ♀	♂ ♀ ♂ ♀	♂ ♀
<p style="text-align: center;">* WITHAM A, BERKS ALL-DAY COLLECTION</p> <p style="text-align: center;">APRIL 22, 1952</p> <p style="text-align: center;">CLEAR DAY AND COOL: WARM "SPRING" WEATHER BROKE THE DAY BEFORE WITH A SHOWER</p>						
8:00	11.5	65% 100- 1600	wind low	- - - -	- - - -	- - - -
9:55	14.5	55% 175	wind stronger but reasonably calm in woods: clouding over large, white, fluffy clouds and very blue sky	- - - -	- - - -	- - - -
11:00	13.3	30% 150- 1600		- - - -	- - - -	- - - -
12:10	17.0	30% 100- 1600		- - - -	- - - -	- - - -
1:24	15.5	30% 1600*		- - - -	- - - -	- - - -
2:45	15.5	- 400		- 1 - - - -	- - - -	- - - -
4:00	11.8	90%* 25	raining and hailing: no wind (very sudden cloud burst)	- - - -	- - - -	- - - -
4:45	10.8	90%		- - 1 - - - -	- - - -	- - - -
5:50	10.4	90%		- - - -	- - - -	- - - -

* Humidity measured with Solomen's papers

TIME	TEMP	HUMID LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUINARIA-GROUP		OTHERS
				SUB. OBSC.	OTHERS	PHAL.	KUNTZ.	
WYTHAM B. BERKS								
APRIL 22, 1952								
ALL-DAY COLLECTION								
7:55		Traps set						
8:10	10.7	75%	wind: very low					
		20-						
		100						
10:15	12.5	60%		1				
		50 ⁺						
		100 ⁺						
11:15	13.8	40%			1 fly escaped			
		100-						
12:26	14.6	40%						
		50						
1:45	14.5	50%		1				
		50			(several flies at traps)			
3:07	12.2	-		1	3	4	1	
		75						
4:00	11.8	90%	rain stopped - still	1	1			
		25	cloudy: rain never					
5:05	10.5	40%	reached floor of woods					
		50						
6:10	10.2	90%						
		13						

* Humidity measured with Solomon's papers

TIME TEMP HUMID LIGHT WIND AND WEATHER

SCOULTON A, NORFOLK
 MAY 8, 1952
 ALL-DAY COLLECTION *

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP			QUINARIA-GROUP			DEFLEXA OTHERS			
					SUB.	OBSC.	OTHERS	PHAL.	KUNTZ.	OTHERS	OTHERS	OTHERS		
4:05	10.5	86%	0.6	day clouded, low breeze, high clouds	12	3	3	5t	--	--	--	--	--	--
5:10	10.5	85%	6.5		?	6	1	--	--	--	--	--	--	--
6:05	12.5	81%	25		16	9	2	1	--	--	1	--	--	--
7:20	18.0	72%	25-1000	sky clear blue; few clouds on the horizon: slight wind: none in woods	?	13	2	1	1t	--	1	--	--	--
8:15	16.5	64%	25-1600*		6	4	-	1	--	--	--	--	--	--
9:15	18.8	60%	25-500		--	--	--	--	--	--	--	--	--	--
10:20	19.0	60%	50-1000		--	--	--	--	--	--	--	--	--	--
11:20	19.6	58%	200-1600*		--	--	--	--	--	--	--	--	--	--
12:45	19.7	62%	200-1600		2	1	-	--	--	--	--	--	--	--
2:10	19.0	58%	50-800		8	5	-	--	--	--	--	--	--	--
3:10	18.5	60%	100	uniform shade due to clouds	58	30	1	2t	--	--	2	--	--	--
4:20	18.7	65%	50	sky uniformly clouded over	40	43	5	2	6t	--	2	1	--	--
5:20	17.5	64%	2.0	clouded over for a storm: thunder and lightning: rain began 5:21	--	--	--	--	--	--	--	--	--	--
6:45	12.5	92%	3.2	still raining	--	--	--	--	--	--	--	--	--	--
7:20	13.5	93%	0.1	pouring rain again	--	--	--	--	--	--	--	--	--	--

* Not used in summary of data

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUINARIA-GROUP		OTHERS	
					SUB. ♂	OBSC. ♀	PHAL. ♂	KUNTZ ♀		
SCOULTON B, NORFOLK										
MAY 8, 1952										
ALL-DAY COLLECTION *										
4:05	10.5	86%	0.6	Day clouded: low breeze, high clouds						
5:10	10.5	85%	6.5							
6:05	12.5	81%	25							
7:20	18.0	72%	25-1000	Sky clear blue: few clouds on horizon	15	14	1	1		
8:15	16.5	64%	25-1600	slight wind: none in woods	16	15		1		
9:15	18.8	60%	25-500		10	2		1		
10:20	19.0	61%	50-1000		5	1				
11:20	19.6	58%	200-1600			2				
12:45	19.7	55%	200-1600			2				
2:10	19.0	58%	50-800	many more shadows	4	1				
3:10	18.5	60%	100	uniform shade due to clouds	11	3	1		2	
4:20	18.7	65%	50	sky uniformly clouded over	12th, 13th and 14th collections combined by mistake					
5:20	17.5	64%	2.0	clouded over for storm: thunder and lightning: rain began 5:21	61	45	4	1	3t	2
6:15	12.5	92%	3.2	still raining						
7:25	13.5	93%	0.1	pouring rain again						

* Not used in summary of data

TIME	TEMP	HUMID	LIGHT	WIND	AND WEATHER	OBSCURA-GROUP			QUINARIA-GROUP			OTHERS	
						SUB.	OBSC.	OTHERS	PHAL.	KUNTZ.	OTHERS		
WYTHAM A, BERKS. ALL-DAY COLLECTION SEPTEMBER 26, 1952 Night very stormy, blowy and rainy and morning calm													
5:30	8.8	79%	0.4	-	-	-	-	-	-	-	-	-	-
6:00	8.6	70%	1.0	-	-	-	-	-	-	-	-	-	-
6:30	8.4	75%	3.2	-	-	-	-	-	-	-	-	-	-
7:05	8.6	76%	6.5	-	-	-	-	-	-	-	-	-	-
7:40	9.3	71%	10.0 ⁺ 50.0 ⁺	-	-	-	-	-	-	-	-	-	-
9:00	11.2	66%	50 ⁻		clouded over	1	-	-	-	-	-	-	-
10:30	11.8	67%	20 ⁻ 100		bright again	-	1	-	-	-	-	-	-
12:05	12.9	63%	50		-	-	1	1	-	-	-	-	-
2:05	13.5	54%	50		-	-	4	-	-	-	-	-	1v
3:40	13.8	50%	35		-	4	3	-	1	-	-	-	-
5:10	11.5	66%	6.5		-	1	2	1	-	-	-	-	1f.
6:10	10.9	78%	0.8		-	-	-	-	-	-	-	-	-

TIME	TEMP	HUMID	LIGHT	WIND	AND WEATHER	OBSCURA-GROUP		QUINARIA-GROUP		OTHERS
						SUB.	OTHERS	PHAL.	KUNTZ	
SE						δ ♀	δ ♀	δ ♀	δ ♀	δ ♀
WYTHAM B, BERKS						δ ♀	δ ♀	δ ♀	δ ♀	δ ♀
ALL-DAY COLLECTION										
SEPTEMBER 26, 1952										
Night very stormy, blowy and rainy: morning calm										
5:45	8.9	76%	0.6	-	-	-	-	-	-	-
7:15	9.1	72%	10.0	-	-	-	-	-	-	-
9:15	11.3	71%	13-	gray and overcast	1	-	-	-	-	-
10:15	12.9	60%	25-	-	-	1 fly on outside	escaped	-	-	-
12:20	13.2	57%	50	-	-	1	-	-	-	-
2:25	13.7	55%	50	-	-	-	-	-	-	-
3:55	13.6	52%	13	-	-	1	2X	-	-	-
5:25	11.9	70%	3.2	-	-	1	-	-	-	-
6:20	10.8	81%	0.6	-	-	-	-	-	-	-

TIME TEMP HUMID LIGHT WIND AND WEATHER

OBSCURA-GROUP SUB. OBSC. OTHERS

QUINARIA-GROUP PHAL. KUNTZ.

OTHERS

WYTHAM A, BERKS
APRIL 15, 1953
ALL-DAY COLLECTION

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP	QUINARIA-GROUP	OTHERS
				GROUND COVER 9": no leaves			
4:00	2.5	93%	0.8	wind:occasional puffs: a few clouds around the horizon	-	-	-
5:30	3.1°	85%	60- 100	clear, blue sky: some wind	-	-	-
7:10	5.5	73%	75- 400	bright, blue sky:no clouds. More wind	-	-	-
8:45	8.5	70%	200- 400	wind:little less than before:clouds coming up: sun not so intense	-	-	-
9:45	9.2	66%	175	wind as before:no direct sun:clouding over:still blue patches	-	-	-
11:30	11.4	53%	110- 800	moderate wind: weather ss before	-	-	-
1:05	12.3	50%	100- 800	wind:occasional puffs: sky more blue	1	-	lf
2:20	12.6	45%	200- 250	clouds and sun: wind almost none	2	-	-
3:40	10.8	44%	100- 250	wind:occasional puffs: sky bright and clear	3	8	lt
5:00	9.2	55%	30	wind: none:slightly overcast	1	-	lt
6:05	8.2	57%	2.0	wind:none: dusk, but still bright	-	-	-

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUINARIA-GROUP		OTHERS
					SUB.	OTHERS	PHAL.	KUNTZ.	
WYTHAM B, BERKS ALL-DAY COLLECTION									
APRIL 15, 1953									
4:15	28°C	93%	1.0	slight breeze:clear day:few clouds along horizon	-	-	-	-	-
5:45	3.8	84%	6.5	wind:very slight on the- ground:clear blue sky	-	-	-	-	-
7:30	5.9	75%	13- 100	wind:very low:bright sky	-	-	-	-	-
9:00	7.9	75%	25	wind: low, clouding over	-	-	-	-	-
10:00	8.4	65%	50	wind:low:clouding over:- still blue patches	-	-	-	-	-
11:45	9.5°C	53%	30- 200	wind low: weather as above	-	-	-	-	-
1:20	10.8	53%	25- 100	no wind: brighter	-	-	2	-	-
2:45	11.3	46%	30	no wind: sun and clouds	-	-	2	3	-
4:00	10.7	44%	8.0	no wind:sky bright and clear	-	-	1	1	16
5:10	9.5	50%	3.2	no wind:slightly over- cast	-	-	1	1	-
6:15	8.5	57%	0.8	no wind	-	-	-	-	-

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP			QUINARIA-GROUP			OTHERS
					SUB.	OBSC.	OTHERS	PHAL.	KUNTZ	OTHERS	
					♂ ♀	♂ ♀	♂ ♀	♂ ♀	♂ ♀	♂ ♀	♂ ♀
					WYTHAM A, BERKS						
					MAY 12, 1953 ALL-DAY COLLECTION						
					Leaves full out on sycamore: just beginning on ash						
4:15	6.9	89%	1.0	no wind:cloudless sky	-	-	-	-	-	-	-
6:20	8.4	85%	30-125	wind:40 ft./min. clear blue sky	-	-	-	-	-	-	-
8:25	11.3	71%	13-800	wind:0-20 ft./min.: cloudless:slightly overcast	-	-	-	-	-	-	-
9:50	12.7	65%	20-125	wind:gusty, 30 ft./ min:blue sky:cloudless slightly hazy	-	1	-	2t	-	-	-
11:30	13.4	62%	25-75	wind:75 ft./min:whitel clouds and lots of blue sky:hazy still	-	-	-	-	-	-	-
1:10	14.9	61%	50	wind:20 ft./min,puffy:1 few thin clouds	-	-	-	-	-	-	-
2:40	14.8	62%	35	wind: 78 ft./min. blue sky	-	1	-	-	-	-	-
4:20	13.9	44%	25-200	wind: 58 ft./min.	2	1	-	-	-	-	-
5:20	14.4	68%	20	wind: 43 ft./min.	3	1	-	1t	-	-	-
6:20	12.1	74%	6.0	wind: 23 ft./min	2	1	-	-	1	-	-
7:20	10.9	76%	1.6	no wind	-	-	-	-	-	-	-

TIME	TEMP*	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP SUB. OBSC. OTHERS	QUINARIA-GROUP PHAL. KUNTZ.	OTHERS
MAY 12, 1953 ALL-DAY COLLECTION WYTHAM C, BERKS							
4:00	{ 4.9	93%	0.8	no wind: cloudless day	- - - - -	- - - - -	- - - - -
	{ 8.1						
6:35	{ 8.5	84%	450	wind: 60 ft./min.: clear, blue sky	- - - - -	- - - - -	- - - - -
	{ 8.2						
8:40	{ 13.9	87%	1000	wind: 245 ft./min.: puffy: some thin, white clouds forming	- - - - -	- - - - -	- - - - -
	{ 13.6						
10:05	{ 16.8	56%	1600 [†]	wind: 275 ft./min.: blue cloudless sky: slightly hazy	- - - - -	- - - - -	- - - - -
	{ 15.8						
11:45	{ 19.7	56%	1600 [†]	wind: 210 ft./min.: over- cast around horizon: clear above	- - - - -	- - - - -	- - - - -
	{ 18.6						
1:20	{ 22.1	53%	1600 [†]	wind: 55 ft./min.: gusty. Few clouds around horizon	- - - - -	- - - - -	- - - - -
	{ 21.9						
2:55	{ 19.2	53%	1600 [†]	wind: 133 ft./min.: sky clear with a few clouds	- - - - -	- - - - -	- - - - -
	{ 20.2						
4:35	{ 15.8	60%	800	wind: 140, gusty	- 1 - - -	- - - - -	- - - - -
	{ 15.2						
5:30	{ 15.3	65%	250	wind: 208 ft./min. cloudless.	- 2 - - -	- - - - -	- - - - -
	{ 14.6						
6:35	{ 11.2	67%	100	wind: 66 ft./min.	- - - - -	- - - - -	- - - - -
	{ 10.9						

* Upper temperature: ground temperature
Lower temperature: air temperature

NOTE 20 cups used

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUINARI A-GROUP		OTHERS
					SUB.	OBSC.	PHAL.	KUNTZ.	
WYTHAM A, BERKS									
MAY 31, 1953									
ALL-DAY COLLECTION									
3:35	8.0	74%	0.2	wind: 4 ft./min.	-	-	-	-	-
4:20	9.9	73%	0.8	wind: 20 ft./min. high clouds: overcast	-	-	-	-	-
6:15	10.2	67%	6.5	wind: 57 ft./min.: clouds around horizon: blue	2	1	-	-	-
7:35	12.1	69%	20.0	wind: 117 ft./min.: clouds and blue sky	1	1	-	-	-
8:55	12.3	64%	10	wind: 66 ft./min.	1	-	-	-	-
10:10	12.2	64%	10	wind: 193 ft./min. completely overcast	-	1	-	-	-
11:30	12.2	67%	13	wind: 94 ft./min.	-	2	1	-	-
12:40	13.2	69%	6.5	wind: 113 ft./min.: com- pletely overcast: open patches of blue sky	1	1	1	-	-
2:05	15.2	57%	10	wind: 98 ft./min.	8	3	2	1	lf -
3:30	17.0	52%	13	wind: 9 ft./min. brighter	9	17	-	1t	-
4:40	13.5	61%	2.0	wind: 65 ft./min.	5	13	1	2X	-
6:05	13.5	70%	1.6	no wind	4	4	1	-	1X lf
7:05	13.3	72%	1.6	no wind	6	2	1	1	1a
8:20	12.9	76%	0.8	no wind	-	1	-	-	-

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP		QUINARIA-GROUP		OTHERS
					SUB. OBSC.	OTHERS	PHAL.	KUNTZ.	
MAY 31, 1953 WYTHAM C, BERKS ALL-DAY COLLECTION									
3:20	{ 5.5 8.0	74%	0.8	wind: 110 ft./min.	-	-	-	-	-
4:35	{ 4.3 9.8	7	13	wind: 278 ft./min. high clouds: overcast	-	-	-	-	-
6:30	{ 13.2 13.3	70%	200- 800	wind: 90 ft./min.: sky blue on top: dark clouds around horizon	-	-	-	-	-
7:50	{ 16.8 16.3	65%	1600 ⁺	wind: 160 ft./min.: gusty: clouds and blue sky	-	-	-	-	-
9:07	{ 16.3 14.9	68%	800	wind: 85 ft./min.: gusty- completely overcast	1	-	-	-	-
10:25	{ 16.1 15.9	67%	800	wind: 110 ft./min.	-	-	-	-	-
11:45	{ 13.0 13.1	68%	400	wind: 119 ft./min.	-	-	-	-	-
12:55	{ 17.9 17.2	67%	800	wind: 61 ft./min.: open patches of blue sky	1	-	-	-	-
2:15	{ 18.6 17.5	54%	400- 1000	wind: 203 ft./min.	-	-	-	-	-
3:45	{ 22.1 20.5	52%	1600 ⁺	wind: 115 ft./min.: brighter	1	-	-	-	-
5:00	{ 14.5 14.8	66%	100	wind: 45 ft./min.	2	-	-	-	-
6:15	{ 14.3 15.0	68%	100	wind: 40 ft./min.	7	-	-	-	-
7:15	{ 13.3 12.9	77%	50	wind: 40 ft./min.	2	-	-	-	-
8:30	{ 12.9 12.5	84%	1.0	wind: 20 ft./min.	1	-	-	-	-

NOTE: 20 cups used

*

TIME TEMP HUMID LIGHT WIND AND WEATHER

OBSCURA-GROUP
SUB. OBSC. OTHERS
δ ♀ δ ♀ δ ♀
WYTHAM A, BERKS
PART-DAY COLLECTION

QUINARIA-GROUP
PHAL. KUNTZ.
δ ♀ δ ♀

OTHERS
δ ♀

APRIL 9, 1952

9:55: Traps set
15.7 90% 800

Traps set

wind from meadow:
quite strong: uniform
cloudiness

11:00 17.2 80% 800

wind: gentle and puffy:
stronger along the mead-
ow: even cloudiness
greater

12:30 19.3 30% 700

wind as before: uniform - 1 - - - -

1:30 20.8 30% 100-
800

wind: as before or less-
cloudiness

2:30 20.8 - 100-
800

wind: less

3:10 19.3 - 75-
500

wind: as before

4:20 17.6 - 150

wind still strong near
meadow: sky uniformly
cloudy

5:20 16.8 - 75

flies on trees as well
as in cups

6:45 14.0 - 1.6

wind: low

1 - 3 2t

1 2 lt lt

* Humidity measured with Solomen's papers

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP	QUINARIA-GROUP	OTHERS
					SUB. OBSC. OTHERS	PHAL. KUNTZ.	
10:15	13.2	90%	100'	WYTHAM B. BEES. wind:puffy on margin: still within wood: above very windy	♂ ♀ ♂ ♀	♂ ♀ ♂ ♀	♂ ♀
11:50	15.5	80%	100'	wind:quiet in woods	8 5 14 28		
12:55	?	30%	100-400	wind: as before	2 3 8 6		
2:10	18.7	-	50-100	wind: as before	16 8 20 15		
2:50	19.0	-	100	sky blue again: wind as before	19 8 9 9 1t		
3:40	18.4	-	50	wind dying:almost no sunny spots	10 6 16 3 1t		
4:50	17.0	-	50	wind: dead calm	15 15 45 27		
5:45	15.5	-	12	wind: dead	33 10 40 19 9t		
7:00	15.0	-	0.2	wind: dead: slight rain	- 1 2 - 1t		

APR 9, 1952

traps set

TIME TEMP HUMID LIGHT WIND AND WEATHER

OBSCURA-GROUP
SUB. OBSC. OTHERS
δ ♀ δ ♀ δ ♀ δ ♀ δ ♀ δ ♀

QUINARI A-GROUP
PHAL. KUNTZ.
δ ♀ δ ♀ δ ♀ δ ♀ δ ♀ δ ♀

DEFLEXA OTHERS
δ ♀ δ ♀ δ ♀ δ ♀ δ ♀ δ ♀

WYTHAM A, BERKS

NOVEMBER 19, 1952
AFTERNOON COLLECTION

Cups out since November 18

1:45 6.2 87% 50
2:30 5.9 87% 30

WYTHAM B, BERKS

NOVEMBER 19, 1952
AFTERNOON COLLECTION

Cups out since November 18

1:50 6.0 85% 13.2
2:45 5.8 84% 6.5

WYTHAM A, BERKS

NOVEMBER 22, 1952
AFTERNOON COLLECTION

Cups out since November 18, 1952

1:45 5.0 93% 100
occasional patches
of blue sky: no
direct sun: no wind

2:35 5.0 82% 75

WYTHAM B, BERKS

NOVEMBER 22, 1952
AFTERNOON COLLECTION

Cups out since November 18

2:00 5.0 84% 20
same as A

TIME TEMP HUMID LIGHT WIND AND WEATHER

OBSCURA-GROUP
SUB. OBSC. OTHERS

QUINARIA-GROUP
PHAL. KUNTZ.

OTHERS

WYTHAM A, BERKS
NOVEMBER 23, 1952
AFTERNOON COLLECTION

WYTHAM B, BERKS
NOVEMBER 23, 1952
AFTERNOON COLLECTION

WYTHAM A, BERKS
NOVEMBER 24, 1952
AFTERNOON COLLECTION

WYTHAM B, BERKS
NOVEMBER 24, 1952
AFTERNOON COLLECTION

Cups out since November 18: rained in morning: overcast and very damp in afternoon

1:50 8.7 90% 75
2:35 6.2 85% 75

Cups out since November 18: same as A

2:10 6.9 84% 25-30
2:45 6.6 96% 20

Bright day: slightly cloudy afternoon: no wind: bitter cold in morning, but sun gave heat

1:30 5.3 84% 200
Same as A
1:40 5.0 77% 25

TIME	TEMP	HUMID	LIGHT	WIND	AND WEATHER	OBSCURA-GROUP	QUINARIA-GROUP	OTHERS
						SUB. OBSC. OTHERS	PHAL. KUNTZ.	
						♂ ♀ ♂ ♀ ♂ ♀	♂ ♀ ♂ ♀	♂ ♀
						WYTHAM A, BERKS		
						AFTERNOON COLLECTION		
						DECEMBER 30, 1952		
						Cups set out December 29, about 3:00		
12:00	1.8	100%	150		almost dead calm heavy mist	-	-	-
1:50	2.3	100%	100		even mistier	-	-	-
						WYTHAM B, BERKS		
						AFTERNOON COLLECTION		
						DECEMBER 30, 1952		
						Cups set out December 29, about 3:00		
12:30	1.9	100%	50		almost dead calm heavy mist	-	-	-
2:00	1.8	100%	25		even mistier	-	-	-
						WYTHAM A, BERKS		
						AFTERNOON COLLECTION		
						DECEMBER 31, 1952		
						Cups set out December 29		
						Warm day, blue sky and bright sun		
1:00	6.9	70%	150- 225		clouding over	-	-	-
2:00	5.8	78%	100		no wind at all	-	-	-
						WYTHAM B, BERKS		
						AFTERNOON COLLECTION		
						DECEMBER 31, 1952		
						Cups set out December 29		
						Warm day, blue sky and bright sun		
1:25	5.8	96%	15		clouded over	-	-	-
2:05	5.6	90%	25-50		no wind at all	1	-	-

TIME TEMP HUMID LIGHT WIND AND WEATHER

WYTHAM A, BERKS
JANUARY 28, 1953 AFTERNOON COLLECTION

Traps set January 27; first warm day, at about 4:00.
Rest of month quite cold

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	SUB. OBS.	OBSCURA-GROUP	OTHERS	QUINARIA-GROUP	OTHERS
12:15	10.8	80%	100	all overcast: no direct sun: some breeze: no wind	♂ ♀	♂ ♀	♂ ♀	♂ ♀	♂ ♀
1:05	11.0	86%	100-150	no sun: overcast: wind as before	- 3	- +	- 1t	- -	- -
2:10	10.6	84%	75	wind as before	2 2	- -	- -	- -	- -
3:05	10.4	84%	50-75	wind as before (possibly a bit stronger)	1 -	- -	- -	- -	- -
3:40	10.3	90%	30	wind: lower	1 -	- -	- -	- -	- -
4:00	10.0	86%	13.0	wind: as before	2 1	- -	- -	- -	- -

WYTHAM B, BERKS
JANUARY 28, 1953 AFTERNOON COLLECTION

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	SUB. OBS.	OBSCURA-GROUP	OTHERS	QUINARIA-GROUP	OTHERS
12:30	10.8	80%	50-75	all overcast: wind very still in woods	1 2	- -	- -	- -	- -
1:25	10.6	83%	50	no wind	2 3	- -	- -	- -	1c
2:25	10.5	84%	30	wind: as before	- 1	- -	- -	- -	1c
3:15	10.4	84%	20.0	wind: as before	- -	- -	- -	- -	- -
4:10	9.8	?	4.0	wind: as before	- 1	- -	- -	- -	- -

3 flies observed: none caught

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP SUB. OBSC. OTHERS ♂ ♀ ♂ ♀ ♂ ♀	QUINARIA-GROUP PHAL. KUNTZ ♂ ♀ ♂ ♀	OTHERS
WYTHAM A, BERKS AFTERNOON COLLECTION							
JANUARY 29, 1952							
large clouds over sun 2 and blue sky: occasional strong puffs of wind clouds gone: virtually 5 1 no wind no wind slight breeze 1 2 no wind							
1 fly: flew away							
Traps set January 27							
1:50	12.5	79%	100+				♂ ♀
3:00	12.5	77%	50-100				
3:55	11.1	85%	75				
4:20	10.8	85%	6.5				
5:00	10.2	91%	3.2				

TIME	TEMP	HUMID	LIGHT	WIND AND WEATHER	OBSCURA-GROUP SUB. OBSC. OTHERS ♂ ♀ ♂ ♀ ♂ ♀	QUINARIA-GROUP PHAL. KUNTZ ♂ ♀ ♂ ♀	OTHERS
WYTHAM B, BERKS AFTERNOON COLLECTION							
JANUARY 29, 1952							
large clouds over sun and blue sky: very bright until about 1:00 no wind 2 5 1 no wind 5 4 no wind 4 no wind							
WYTHAM A, BERKS MORNING COLLECTION							
JANUARY 30, 1952							
WYTHAM B, BERKS MORNING COLLECTION							
JANUARY 30, 1952							
no wind 1							
Traps set January 27							
2:00	11.8	79%	30				
3:15	11.2	81%	25				1c 2c
4:05	10.8	83%	10				
5:05	10.3	92%	0.8				
8:15	7.8	87%	6.5				
8:30	7.5	87%	4.0				