DROSOPHILIDAE (DIPTERA) WITHIN THE ARCTIC CIRCLE. I. GENERAL SURVEY.

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CONTENTS

Introduction.

The Holarctic zoogeographical region includes all the land north of the Tropic of Cancer (lat. 23° 27′ N.), except India and contiguous parts of south-east Asia and parts of Mexico. The European, North African and Asiatic parts are distinguished as the Palaearctic region ; and the North American and Greenland as the Nearctic. Very few of the 1,000 or so known world species of Drosophilidae occur in both the Palaearctic and the Nearctic and a large proportion of these few are cosmopolitan (Patterson and Stone, 1952, chap. 3, for *Drosophila*). Also some species-groups that occur in both regions are represented by distinct though similar species, it being assumed that the species of each group have diverged from a common ancestor (Patterson and Wagner, 1943 : 251). This suggests that geographical, climatological, or ecological barriers are now almost completely *naturally* insurmountable between the two regions.

It is of interest to know the northernmost limits of distribution in order to help ascertain what the barriers are to population exchange ; for it is in the northern Holarctic that the land masses are most continuous or closest. It is known that Diptera may be dispersed in the arctic by wind (Elton, 1925, 1929 ; Brinck & Wingstrand, 1949 : 20) or by ship (Collin, 1925 ; and the notes in Gerstäcker and Pansch, 1874 ; Strand, 1941 : 4). Also this northern fringe of distribution will be occupied by marginal populations, which are of interest to compare genetically and otherwise with populations inhabiting the centre of the species range ; and northern populations, of the non-cosmopolitan species, will be largely discontinuous between the Nearctic and Palaearctic regions and may exhibit different degrees of evolutionary divergence (speciation). This paper surveys the little information we have on some of these points.

The southern limit chosen, the Arctic Circle (lat. 66° 32′ N.), is, of course, an artificial limit, there being some places south of it, e.g. in Canada, that have a more " arctic " climate than parts north of it, e.g. northern Norway. However the term *arctic* (with small initial letter) when used in this paper, means north of the Arctic Circle. Polunin (1951) has given a precise definition of the real Arctic, and Semenov-Tian-Shanskij (1935) has usefully divided the Palaearctic region into zones according to the beetle fauna.

There are now (early 1955) more than 680 known world species of the genus *Drosophila*, of which 92 per cent. are endemic to one or other of the six zoogeographical regions (figures based mainly on Patterson and Stone, 1952, chap. 3, and Burla, 1954). Of the remaining 8 per cent. eight species occur in all six regions, doubtless because they are synanthropous outside their native areas. In the Palaearctic region there are almost a hundred known species of *Drosophila*, and about a hundred and fifty in the Nearctic (Patterson and Stone, 1952, Table 8, with later additions). The other genera in the family are represented by about fifty known species in the Palaearctic and by about seventy-five species in the Nearctic.

2. Holarctic Species.

Since the arctic regions cover the northernmost areas of the Palaearctic and the Nearctic it will be of interest to know how many species of Drosophilidae are common to the last two regions and how many of these occur within the Arctic Circle. These Holarctic species are listed in Tables I and II. Some records have doubtless been missed, but I have been very fortunate to receive additional lists or specimens from Canada, Denmark, Finland, Norway and Sweden.

Names preceded by a question mark (?) in the Tables are probably not the same species in the different regions even though they have been recorded under the same name, the Nearctic species being less certainly correctly identified. This confusion of identity is greater within the genera other than *Drosophila*. For those species with a question mark the most northerly record is given for both regions, the Palaearctic first. Although Europe and Japan are classed as Palaearctic, their drosophilid faunas differ in several species, and an asterisk (*) shows that a species or species-group occurs in Japan but not in Europe. Distribution beyond the Holarctic is abbreviated as A = Australian region ; C = Cosmopolitan ; E = Ethiopian ; N = Neotropical ; O = Oriental region.

With reference to Table I, I have examined progeny of a female *D. hydei* Sturtevant caught *c.* 1941 by Dr. V. Kiil in Oslo, which had previously been circulated as *D. repleta* Wollaston.

Frey (1917 : 97) records *D. melanogaster* from the Kuopio district of Finland (63° N.), but this must be another species (probably *D. fenestrarum*) than the one now associated with the name, for his 1918 record, as *D. ampelophila* Loew, was the first for Finland.

The species-groups of *Drosophila* recognised in the Palaearctic and Nearctic but having no one common representative are five :

fenestrarum-group ;
melanderi-group (Burla and Gloor, 1952 : 168—" *pallida* " being *cameraria* Hal.) ;
melanica-group ;

obscura-group (subgroups *a* and *b*);
**robusta*-group ; with perhaps the
victoria-group, though *D. lebanonensis* Wheeler (Palaearctic) and *D. victoria* Sturtevant (Nearctic) may be conspecific (Buzzati-Traverso and Scossiroli, 1952 : 248). In addition, the subgenus *Hirtodrosophila*, which is not satisfactorily classified into species-groups, contains distinct Palaearctic and Nearctic species.

TABLE 1.—*Holarctic species of* Drosophila.

Species.	Species-group.	Distribution outside Holarctic.	Most northerly record.	Authority.
Drosophila ananassae Dol.	Melanogaster sub-group *a*	C	55° 57′, Edinburgh.	Basden, 1954*a*.
D. busckii Coq. . .	Busckii.	C	" Norway."	Sturtevant, 1921.
			60° 9′, Helsinki.	Suomalainen, 1937.
D. funebris (Fabr.) .	Funebris.	C	69° 47′, Utsjoki.	Frey, 1950.
D. hydei Sturt. . .	Repleta.-a	C	59° 54′, Oslo.	Specimens in Inst. Genetics, Oslo.
D. immigrans Sturt.†	Immigrans.	C	" Norway."	Sturtevant, 1921.
			55° 57′, Edinburgh.	Basden, 1954*a*.
			56° 2′, Hälsingborg, Sweden.	Ringdahl collection.
D. melanogaster Mg. .	Melanogaster sub-group *b* .	C	61° 28′, Tampere, Finland.	Hackman, 1954.
D. mercatorum P. & W.	Repleta.-b	A, N	41° 22′, Barcelona.	Prevosti, 1953.
D. polychaeta P. & W.	Polychaeta.	A, ? E, ? O	53° 25′, Liverpool (in ships).	Sobels and Basden, 1953.
			50° 53′, Limburg dist.	
D. repleta Woll. .	Repleta.-a	C	53° 30′, Manchester.	Colyer, 1954.
D. simulans Sturt. .	Melanogast.-b.	C	56° 2′, Inverkeithing.	Basden, 1954*a*.
D. testacea v. Ros. .	Testacea.	—E	61° 16′, Kokemäki, Finland.	Hackman, 1954.
D. ? *transversa* Fall. .	Quinaria.	O	69° 47′, Utsjoki.	Frey, 1950.
			Approx. 46° 48′, ? Duluth.	Patterson and Wagner, 1943 (map 4).
			46° 48′, Quebec.	Canad. Nat. collection.
D. **virilis* Sturt. .	Virilis.	N, O	46° 34′, S. Sakhalin.	Kikkawa and Peng, 1938.
In addition, if *D. victoria* and *D. lebanonensis* are conspecific (see above) :				
D. victoria Sturt.	Victoria.	Nearctic.	Approx. 48°, "N.E. Montana."	Wheeler, 1949.
D. lebanonensis Wheel.		Palaearctic.	33° 53′, Beirut.	

† The validity of the name *immigrans* Sturt. is due for consideration by the International Commission on Zoological Nomenclature (1954, *Bull. zool. Nomencl.* **9** : 161–162, 342–346).

Thus the total species of *Drosophila* found in both regions is only thirteen (fourteen with *D. victoria*), representing nine species groups (ten with *victoria*) ; and the total species-groups is sixteen (including *victoria*-group and *Hirtodrosophila*). Only one species, *D. testacea*, is purely Holarctic, (except perhaps *D. victoria*), the others being cosmopolitan or approaching so. Two only of the

thirteen species are found north of the Arctic Circle, *viz. D. funebris* and *D. transversa*.

Other supposedly Holarctic species of Drosophilidae are listed in Table II.

TABLE II.—*Holarctic species of Drosophilidae* (continued).

Species	Most northerly record.	Authority.
Amiota ? *alboguttata* (Wahl.)	69° 27′, Furuflaten, Norway.	Basden and Harnden, *in press.*
	40° 43′, "New York."	Wheeler, 1952 : 169.
	[Approx. 45° 20′, Parry Sound—? under *Stegana humeralis* Lw.]	[Sturtevant, 1921.]
A. ? *leucostoma* Lw. (? = *rufescens* (Old.))	44° 54′, Mehadia, Hungary.	Duda, 1934.
	59° 40′, Ingria (W. of Leningrad.)	Stackelberg, 1930 (v. remark, p. 5).
	Approx. 41°–47°, "New York, Maine, Michigan."	Wheeler, 1952.
	45° 26′, Aylmer, Ottawa.	Canad. Nat. collection.
Chymomyza ? *caudatula* Old.	Approx. 47°, "Homorod-furdo."	Duda, 1934.
	46° 42′, Pullman. Washington.	Sturtevant, 1921 : 62.
	Approx. 43°–47°, "Maine."	Wheeler, 1952.
Parascaptomyza ? *disticha* (Duda) (= *Scaptomyza graminum* auctt)	70° 14′, Torsvaag, Norway.	Tromsø Museum collection.
	57° 16′, St. Pauls Island.	Malloch, 1923.
Scaptomyza ? *montana* Wheel.	[57° 8′, Kinrara, Scotland.]	[Basden, 1954*a*.]
	68° 56′, Inari, Finland.	W. Hackman, (1955).
	48° 40′, Glacier National Park.	Wheeler, 1952.
S. ? *teinoptera* Hack.	69° 47′, Utsjoki, Finland	Hackman, 1955.
	57° 4′, Sitka, Alaska	
Stegana ? *coleoptrata* (Scop.) .	66° 53′, Korpilombolo, Sweden.	Specimen in Zool. Inst., Lund.
	58° 48′, Fort Nelson, B.C.	Canad. Nat. Collection.
Protostegana ? *curvipennis* (Fall.)	Approx. 67° 20′, Sarek district.	Poppius *et al.*, 1917.
	[Approx. 42°–47°, "Michigan."	References in Wheeler, 1952 : 211.]

Other species-groups of *Scaptomyza*, e.g. *terminalis*-group, are thought to be represented in both regions (Wheeler, 1952 ; Hackman, 1955).

Tables I and II show that, excluding *D. victoria*, only twenty-one species of Drosophilidae are thought to occur in both the Palaearctic and Nearctic. Nine of these, probably more, are doubtfully conspecific in both regions so the total of twenty-one is a maximum. Only eight of the twenty-one holarctic species are found within the Arctic Circle, and of these eight only *D. funebris* is cosmopolitan in distribution.

From the most northerly records given in Tables I and II it appears that the species are more southerly in distribution in the Nearctic. This may not prove so, however, when the northern Alaskan and Canadian faunas have been thoroughly investigated, such as in the Mackenzie area, which is well wooded (Camsell & Malcolm, 1919 ; Dutilly, 1946).

It is apparent that the arctic does not now serve as a very efficient highway, if one at all, between the Palaearctic and Nearctic regions, and that very little

interchange of *species* takes place by any route. Five of the eight species that do penetrate the Arctic Circle and which might be considered the most able to take advantage of any arctic route, are not known to occur in those countries (N.E. Siberia, Alaska, N. Canada, Greenland, Spitsbergen, or Iceland) through which such routes might pass. *P. disticha* occurs in Iceland and in N. America, but only *D. funebris* is known to have a somewhat linked-up distribution (Europe-Iceland-Greenland-Canada), but does not pass beyond the Arctic Circle in Iceland or Greenland.

A few observations will indicate the general confusion concerning the identity of Nearctic and Palaearctic species.

Twenty specimens identified as *Stegana alboguttata* (Wahl.) from the Canadian National Collection do not agree with the European *A. alboguttata* (Wahlberg) as I understand this species.

Duda (1934 : 33) considers that *Amiota* (*Phortica*) *rufescens* (Oldenberg) and *A.* (*P.*) *lacteoguttata* (Portschinsky) are synonyms of *A. leucostoma* Loew. Stackelberg (1930) recorded a *lacteoguttata* from Ingria, but this was apparently the same species recorded by Oldenberg (1914 : 23) as *lacteoguttata*, which Duda (1934 : 33) named *A. flavopruinosa* sp. n. Therefore Stackelberg's record from Ingria should not be included in Table II. However, Duda (1934 : 34) partly bases a description of *A. leucostoma* upon two specimens determined by Stackelberg as *lacteoguttata*, " aus Russland ". It is likely, therefore, that Stackelberg's Ingria specimens were, after all, *A. leucostoma*.

Dr. M. R. Wheeler sent me a specimen labelled *Chymomyza* ? *distincta* from his Olympic National Forest series (Wheeler, 1952 : 179), but it is distinct from the European *distincta* or *fuscimana*. Therefore *distincta* is omitted from Table II. This does not preclude, however, the occurrence of either European species in the Nearctic. There is confusion between the last two species because the one specimen in Zetterstedt's *Insecta Lapponica* collection labelled " *D. fuscimana* ♂ Nordanås " and the other in his *Diptera Scandinaviae* collection labelled " *D. fuscimana* ♂ Nästansjö," and which are to be taken as the type specimens of *Chymomyza fuscimana*, have the genitalia of Oldenberg's (1914, fig. 3) *C. distincta* Egger and of Duda's (1934, fig. 18) *Ch. nigrimana* Meigen (= *distincta* sensu Oldenberg). On the other hand, Oldenberg and Duda incorrectly use the name *fuscimana* for the real *distincta* Egger. (I express my appreciation here to Mr. P. Ardö, Lund, for arranging that I see this and other Zetterstedt specimens ; to Prof. W. Hennig, Berlin, for Oldenberg's specimens ; and to Dr. M. Beier, Vienna, for Egger's specimens.)

An examination of Nearctic specimens named as " *Scaptomyza graminum* " (Fallén) from Prof. H. D. Stalker, St. Louis, Missouri, and from the Canadian National Collection shows that they are certainly *Parascaptomyza* and close to, if not identical with, the European *P. disticha*. [*Later note :* The St. Louis strain is found to breed readily with British strains of *P. disticha*, but is not wholly compatible with a Spanish strain (1955, Basden, *Drosophila Inform. Serv.* **29**]. Other similar species do occur in N. America, so Malloch's record (Table II) may not be *P. disticha*. The real European *S. graminum* is distinct from the Nearctic " *S. graminum* " (Basden, 1952 ; Collin, 1953). Hackman (1955 : 76) includes *S. graminum* in the *montana*-group (Wheeler, 1952 : 196) but *S. graminum* has short apical scutellars.

It is not established that the Scottish and Finnish *S. ?montana* are the same species ; and my British *?montana* do not agree with American specimens of *S. montana* from Dr. M. R. Wheeler.

Stegana coleoptrata sens. lat., sensu Duda (1934), contains a few good species, which remain to be worked out. When this is done the Nearctic-Palaearctic relationship of the species should be clear. The specimen from Korpilombolo is probably the real *coleoptrata*.

I can confirm Wheeler's conjecture (1952 : 212) that (*Proto*) *Stegana vittata* (Coquillet) is not the same as the European *P. curvipennis* (Fallén), after examining a specimen of the former lent me by Dr. Wheeler.

Another species that may be Holarctic, though not included in Table II, is the European *Scaptomyza apicalis* Hardy (= *flaveola* Meigen). *S. flaveola* was recorded from Sitka, Alaska (approx. 57, N.) by Coquillet (1900 : 462), but Sturtevant (1921: 106) says that *S. flaveola* does not occur in the North American region ; and the species is not known in U.S.A. to Wheeler (1952 : 194), and *see* Frost (1924 : 92, 167). Winn *et al.* (1932), however, use this name for a species from Quebec province.

The *fenestarum*-group is Nearctic by one male in the U.S. National Museum, Washington, labelled " E. Lansing, Mich. 4 May 1949. Ryoji Namba Collector ". It was provisionally named by Dr. Willis W. Wirth as *D. fenestrarum* Fallén but it is not that or the two other Palaearctic species known to me.

3. Arctic Species.

Records of Drosophilidae from north of the Arctic Circle (66° 32′ N.) are given below. Zetterstedt's 1840 records are repeated in his *Diptera Scandinaviae*, Vol. 6 (1847). Those in Ringdahl (1951 : 147) are from the literature, so are not referred to here. The records of specimens in the Museum Zoologicum Universitatis, Helsinki, were sent by W. Hackman (*in litt.*, 27th September, 1954 and 19th February, 1955), the specimens being collected by R. Frey, R. Krogerus, J. A. Palmén, W. Hellén, or J. Sahlberg : some are repeated in Hackman (1954). The specimens in the Tromsø Museum were examined through the kindness of Dr. T. Soot-Ryen, the collector ; and those in the Zoological Institute, Lund, through Mr. P. Ardö. Specimens checked by me are preceded by a dagger (†).

1. *Drosophila obscura* Fallén. Palaearctic.

†[Öfver-Torneå	(Sweden)	66° 22′ N., 23° 40′ E.	(Zetterstedt, 1840 : 776.)
Frequent on 29th May. (Northwards it was scarce except on birch (*betuletis*) at O-T—Zetterstedt, 1847 : 2549.)]			
†Skjåvikør	(Norway)	69° 17′ N., 19° 0′ E.	(Tromsø Museum.)
†Furuflaten	(Norway)	69° 27′ N., 20° 10′ E.	(Basden & Harnden, *in press.*)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)
Muonio	(Finland)	67° 55′ N., 23° 40′ E.	(Mus. Zool. Univ. Helsinki.)
Pelkosenniemi	(Finland)	67° 5′ N., 27° 27′ E.	(Hackman, 1954.)

2. *D. bifasciata* Pom. Palaearctic.

†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)

3. *D. silvestris* Basden. Palaearctic.

†Furuflaten	(Norway)	69° 27′ N., 20° 10′ E.	(Basden & Harnden, *in press.*)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)

4. *D. funebris* (Fabricius). Cosmopolitan.

Karesuando	(Sweden)	68° 29′ N., 22° 40′ E.	(Zetterstedt, 1840 : 775.)
†Furuflaten	(Norway)	69° 27′ N., 20° 10′ E.	(Basden & Harnden, *in press.*)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)
†Jotkajavre	(Norway)	69° 45′ N., 23° 48′ E.	(Tromsø Museum.)
†Tromsø	(Norway)	69° 38′ N., 18° 57′ E.	(Tromsø Museum.)
†Øverbygd	(Norway)	69° 0′ N., 19° 10′ E.	(Tromsø Museum.)
†Skjåvikør	(Norway)	69° 17′ N., 19° 0′ E.	(Tromsø Museum.)
Enontekio	(Finland)	68° 22′ N., 23° 35′ E.	(Mus. Zool. Univ., Helsinki.)
Kilpisjarvi	(Finland)	69° 0′ N., 20° 45′ E.	(Mus. Zool. Univ., Helsinki.)
Pihtioja, Utsjoki	(Finland)	69° 47′ N., 27° 0′ E.	(Frey, 1950 : 13) In a room.
Turtola	(Finland)	66° 40′ N., 24° 2′ E.	Zetterstedt, 1840 : 775.)
Kantalahti	(Russia)	67° 9′ N., 32° 30′ E.	(Mus. Zool. Univ., Helsinki.)

5. *D. littoralis* Meigen (= *lugubrina* Duda). Palaearctic.

Gellivara	(Sweden)	67° 10′ N., 20° 40′ E.	(Duda, 1935 : 88.)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)
Muonio	(Finland)	67° 55′ N., 23° 40′ E.	(Mus. Zool. Univ., Helsinki.)
Provinces Lapponia kemensis (Finland) and L. petsamöensis (Russia) (Frey, 1929—see *Mus. Zool. Univ.*)			
Petsamo	(Russia)	69° 25′ N., 30° 52′ E.	(Mus. Zool. Univ., Helsinki.)

6. *D. phalerata* Meigen. Palaearctic.

†Skjåvikør	(Norway)	69° 17′ N., 19° 0′ E.	(Tromsø Museum.)

7. *D. transversa* Fallén. Palaearctic, ? Nearctic, ? Oriental.

W(V)ittangi	(Sweden)	67° 40′ N., 21° 40′ E.	(Zetterstedt, 1840 : 776.)
Few females 14th June under bark of pine.			
†Jebrenjokk	(Sweden)	"North side of Torne-träsk."	(Ringdahl, 1931 : 26.)
In birch wood.			
Utsjoki	(Finland)	69° 47′ N., 27° 0′ E.	(Frey, 1950 : 13.)
In a copse on a slope.			
†Furuflaten	(Norway)	69° 27′ N., 20° 10′ E.	(Basden & Harnden, *in press.*)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)
[nr. Apatity]	(Russia)	67° 30′ N., 33° 15′ E.	(Hackman, 1954, map.)

8. *D. fenestrarum* Fallén. Palaearctic.

†Aspenes	(Norway)	69° 17′ N., 18° 55′ E.	(Tromsø Museum.)
†Frihetsli	(Norway)	68° 46′ N., 19° 45′ E.	(Tromsø Museum.)
†["Lapponia Tornensi" (Northernmost province of Sweden) (Zetterstedt, 1840 : 776.) 1 ♀ in Zett. *Insecta Lapponica* Coll., Lund, is labelled "*D. Fenestrarum* ♂ Torneå." Öfver-Torneå is 66° 22′ N., 23° 40′ E.]			
[Kuusamo	(Finland)	65° 58′ N., 29° 5′ E.	(Hackman, 1954.)]

9. *Scaptomyza graminum* (Fallén). Palaearctic.

The following specimens are certainly *S. graminum*, with 4 rows acrostichals (= *Sc. incana* Mg.) :

†Kengis	(Sweden)		(Zetterstedt, 1840 : 777.)
Kengis is about 100 Km. north of the Arctic Circle (O. Ringdahl, *in litt.*).			
Kittilä	(Finland)	67° 38′ N., 24° 56′ E.	(Mus. Zool. Univ., Helsinki.)
Muonio	(Finland)	67° 55′ N., 23° 40′ E.	(Mus. Zool. Univ., Helsinki.)
Utsjoki	(Finland)	69° 47′ N., 27° 0′ E.	(Frey, 1950 : 13, as *incana.*)
†Torsvaag	(Norway)	70° 14′ N., 19° 30′ E.	(Tromsø Museum.)
†Måkeskjaer	(Norway)	70° 10′ N., 19° 0′ E.	(Tromsø Museum.)

10 *S. apicalis* Hardy (= *flaveola* Meigen of authors). Palaearctic. [? Nearctic.]

†Stalojokk	(Sweden)	67° 17′ N., 16° 40′ E.	(Brinck & Wingstrand, 1949 : 27, 30 ; 1951 : 106.)

In willow thicket on *Empetrum* heath.

This was recorded as *S. graminum*, but I have seen the specimen (1 ♂, pinned, *in* Univ. Zool. Inst., Lund). It is reddish-brown in colour (? been in alcohol) instead of the normal yellow or grey-yellow.

11. *S. trochanterata* Collin. Palaearctic.

Pelkosenniemi*	(Finland)	67° 5′ N., 27° 27′ E.	(Mus. Zool. Univ., Helsinki.)

12. *S.* ? *montana* Wheeler. Nearctic, ? Palaearctic.

Inari (Enare)	(Finland)	68° 56′ N., 27° 2′ E.	(Mus. Zool. Univ., Helsinki.)

[Tiensuu (1951) records *Sc. pisi* sp. n. (*nomen nudum*) from Tornio, Finland (65° 48′ N.) but W. Hackman (*in litt.*) tells me this is *S. montana* sensu Collin, 1953.]

13. *S. teinoptera* Hackman. Palaearctic, ? Nearctic.

Muonio	(Finland)	67° 55′ N., 23° 40′ E.	(Hackman, 1955.)
Kittilä	(Finland)	67° 38′ N., 24° 56′ E.	(Hackman, 1955.)
Pallastunturi	(Finland)	68° 0′ N., 23° 50′ E.	(Hackman, 1955.)
Utsjoki	(Finland)	69° 47′ N., 27° 0′ E.	(Hackman, 1955.)

14. *S. griseola* (Zetterstedt). Palaearctic.

Muonio	(Finland)	67° 55′ N., 23° 40′ E.	(Hackman, 1955.)
Kittilä	(Finland)	67° 38′ N., 24° 56′ E.	(Hackman, 1955.)
Pallastunturi	(Finland)	68° 0′ N., 23° 50′ E.	(Hackman, 1955.)

15. *Parascaptomyza disticha* (Duda). Palaearctic, Nearctic, ? Australian.

The following specimens are certainly *P. disticha*, with 2 rows acrostichals :

Salla	(Finland)	66° 40′ N., 29° 30′ E.	(Mus. Zool. Univ., Helsinki.)
Karigasniemi	(Finland)	69° 47′ N., 27° 0′ E.	(Frey, 1950, as S. *graminum*.)
Utsjoki			
[Swedish lappland. (Wahlgren, 1927 : 356, as *P. graminum*.)]			
†Pajala	(Sweden)	67° 10′ N., 23° 30′ E.	(Univ. Zool. Inst., Lund.)
†Aspenes	(Norway)	69° 17′ N., 18° 55′ E.	(Tromsø Museum.)
†Tromsø	(Norway)	69° 38′ N., 18° 57′ E.	(Tromsø Museum.)
†Måkeskjaer	(Norway)	70° 10′ N., 19° 0′ E.	(Tromsø Museum.)
†Torsvaag	(Norway)	70° 14′ N., 19° 30′ E.	(Tromsø Museum.)
†Hushattøy	(Norway)	70° 12′ N., 18° 35′ E.	(Tromsø Museum.)

16. *Chymomyza costata* (Zetterstedt). Palaearctic.

Torneträsk Lake	(Sweden)	68° 20′ N., 19° 0′ E.	(Zetterstedt, 1840 : 776.)
†Furuflaten	(Norway)	69° 27′ N., 20° 10′ E.	(Basden & Harnden, *in press.*)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)
Kilpisjarvi	(Finland)	69° 0′ N., 20° 45′ E.	(Mus. Zool. Univ., Helsinki.)
Kola	(Russia)	68° 51′ N., 33° 8′ E.	(Mus. Zool. Univ., Helsinki.)
Ponoj	(Russia)	67° 5′ N., 41° 5′ E.	(Mus. Zool. Univ., Helsinki.)

17. " *C. distincta* " auctt = *fuscimana* Zetterstedt. Palaearctic.

Gellivare	(Sweden)	67° 10′ N., 20° 40′ E.	(Oldenberg, 1914 : 17.)

1 ♂ at felled (cut) wood.

18. *C. albopunctata* (Becker). Palaearctic.

Insel Nikander (=Nikandrik)	(Siberia)	70° 40′ N., 83° 15′ E.	(Becker, 1900 : 64.)

19. *Amiota alboguttata* (Wahlberg). Palaearctic, ? Nearctic.

†Furuflaten	(Norway)	69° 27′ N., 20° 10′ E.	(Basden & Harnden, *in press.*)
†Rosta	(Norway)	68° 58′ N., 19° 45′ E.	(Basden & Harnden, *in press.*)

* Not confirmed by Hackman (1955).

20. *Cacoxenus argyreator* Frey. Palaearctic.
†Furuflaten (Norway) 69° 27′ N., 20° 10′ E. (Basden & Harnden, *in press.*)

21. *Stegana strobli* Mik. Palaearctic.
Muonio (Finland) 67° 55′ N., 23° 40′ E. (Frey, 1929.)

22. *St. coleoptrata* (Scopoli). Palaearctic, ? Nearctic.
†Korpilombolo (Sweden) 66° 53′ N., 23° 0′ E. (Univ. Zool. Inst., Lund.)

23. *Protostegana curvipennis* (Fallén). Palaearctic, ? Nearctic.
Sarek region (Sweden) 67° 20′ N., 17° 35′ E. (Poppius *et al.*, 1917 : 696.)

To summarise : thirteen species have been found in arctic Norway ; ten in Sweden, with two more near the arctic limit ; twelve in Finland, with one more near the arctic limit ; four in European Russia ; one in Siberia ; and nil in arctic parts of Alaska, Canada, or Greenland, or in the arctic Islands.

Scaptomyza (*Geomyza*) *unipunctum* (Zetterstedt) may be found in the arctic, as it has been recorded from Kuusamo, Finland (65° 58′ N., 29° 5′ E.) by Frey (1929).

4. Common Species Not or Rarely Found Within the Arctic Circle.

Some species of Drosophilidae that are abundant or widespread in northern regions have not been found within the Arctic Circle. They may be absent because they have not reached the area or because they cannot exist in the hostile environment ; or are only presumably absent because of inadequate or inefficient collecting. A knowledge of the reasons for their absence would be an important contribution to understanding their general distribution. Examples of the more obvious absentees of the genus *Drosophila* are selected from the northern European fauna, since this is the only drosophilid fauna adjacent to the arctic that is well known.

The species that is most surprisingly missing is *D. subobscura* Collin. It is the most widespread species in Scotland (but not found in Shetland), and is there the most cold-hardy in the sense that its adults are active throughout the winter (Basden 1953, 1954*a*). Burla (1951 : 157) found it higher than any other species in the Swiss Alps, at 2000 metres, which also suggests it is cold-hardy. Nevertheless not one specimen was obtained by Harnden in arctic Norway (Basden and Harnden, *in press*). It occurs commonly to the north of Denmark (O. Frydenberg, *in litt.*, 28th September, 1954) ; up to Stockholm, Sweden (in the collection of the University Institute of Zoology, Lund); and around Oslo, Norway, lat. 59° 54′ N. (V. Kiil, *fide* O. Strömnaes *in litt.* 9th October, 1954). The last is the farthest north it is known, so its northern edge of distribution must lie somewhere between Oslo-Stockholm and arctic Norway. It has not been found in Finland (Hackman, 1954). It seems likely, therefore, that *D. subobscura* is dependent upon a source of food that is absent from the arctic, e.g. the sap of a particular species of tree, rather than being excluded by the climate.

D. phalerata Meigen, of which only a single arctic specimen has turned up, should not be repressed by lack of food since it breeds in a wide range of fungi, as does the closely related relatively common arctic species, *D. transversa*. The former has been reared from *Russula cyanoxantha* Friesin, Scotland, where it is common (Basden, 1954*a*) ; and *Russula* spp. and other toadstools have been

found beyond the 76° parallel in north-east Greenland (Ferdinandsen, 1910 : 141). *D. phalerata* in the northern countries is otherwise known only south of 62° N. lat. in Finland (Hackman, 1954) ; in southern Sweden (Wahlgren, 1927 ; and specimens in the Zoological Institute, Lund) ; and southern Norway (University Museum of Zoology, Oslo). It is probably kept down in the arctic by climatic conditions.

Both *D. subobscura* and *D. phalerata* are apparently more southerly-ranging (more heat tolerant?) than *D. obscura* (= *obscuroides*) and *D. transversa*, the arctic species with which one would naturally compare them, as the former pair, but not the latter, are found in the Lebanon (Pipkin, 1952) ; and the first two species occur in greater numbers (in late summer) in south-west Europe than do the last two (Hadorn *et al.*, 1952).

D. tristis Fallén is another species that might be expected in the arctic. It occurs in small numbers up to northern Demark (O. Frydenberg, *in litt.*, 28th September, 1954) and it is reported from south Sweden (Zetterstedt, 1847 : 2555 ; later specimens in Ringdahl collection) but not from Finland (Hackman, 1954). In Scotland the adult is active, though in fewer numbers, during the same winter months, as is *D. obscura*, which species is abundant in the arctic.

The cosmopolitan species that are most likely to reach the Arctic Circle, if only as summer visitors, but have not done so, are *D. melanogaster*, *D. busckii*, *D. immigrans*, and *D. hydei*. The first species is known from southern Sweden (Wahlgren, 1927 : 399) and Finland (Table I) ; *D. busckii* occurs in Norway and Finland (Table I) and Sweden (1 ♂, Höör ; 1 ♂, 1 ♀, Lund ; 2 ♂, 2 ♀, Trönninge Laxvik, in Zoological Institute, Lund) ; *D. immigrans* in Norway (Table I) and Sweden (2 ♂, 2 ♀, Hälsingborg, Ringdahl collection) ; and *D. hydei* in Norway (Table I) and south Sweden (1 ♀, Wiad. produced a stock (Rew) now kept at the Genetics Institute, Stockholm). All four species are present in Denmark (Frydenberg, *in litt.*, 28th September, 1954). The first three species have been found in Canada but not north of lat. 52° 9′ (McAlpine, *in litt.*, 14th October, 1954). An example of how *D. melanogaster* could be imported artificially into the arctic is given in Basden and Harnden (*in press*).

D. testacea is perhaps the most interesting species to consider here for, assuming that its Nearctic and Palaearctic populations are conspecific, it is the only species of *Drosophila* that is common to and confined to these two regions. (*D. victoria* may prove to be a second such species, *antea*, p. 3). In the Nearctic it has been found up to lat. 50° 15′ N., Trinity Valley, B.C., Canada (1 ♀ in the Canadian National Collection). In northern Europe it is not a common species, viz., southern England, two specimens (Basden, 1952 ; Collin 1952) ; Denmark, sparsely (O. Frydenberg, *in litt.*, 28th September, 1954) ; Ingria (Stackelberg, 1930) ; and southern Finland, rare (Hackman, 1954). From southern Sweden, up to Stockholm, I have seen 17 ♂, 16 ♀ obtained by T. Nyholm (in the collection of the Zoological Institute, Lund). It also occurs in Japan. It certainly cannot be considered an arctic species in any way, not being recorded north of lat. 61° 16′ N. (Table I).

5. Discussion.

Twenty-three species of Drosophilidae out of the world's known total of probably 1,000 have been collected north of the Arctic Circle, twenty-two in Europe and one in Siberia. The *Drosophila* sp. in Basden & Harnden (*in*

press) is excluded for the time being. Some doubtless occur in arctic parts of the Nearctic region, as eight of the twenty-three species have been reported from the southern Nearctic, and these eight are the only arctic species to occur in both Palaearctic and Nearctic regions (Tables I, II). They are *D. funebris*, *D. transversa*, *Amiota alboguttata*, *Parascaptomyza disticha*, *Scaptomyza montana*, *S. teinoptera*, *Stegana coleoptrata*, and *Protostegana curvipennis*. As yet only *D. funebris* and *P. distincta* can certainly be considered good species to both regions, the others may be each represented by distinct species in the two regions. Even with *D. funebris* there are signs of speciation (Perje, 1954 : 275).

Faunistic explorations and collections within the Arctic Circle have been continuing from the days of Kirby (1824), Ross, and Curtis ; and numerous detailed accounts of the insect life have been published (*vide* References *re* Diptera), so the low total of twenty-three species of Drosophilidae does show a real paucity within the Arctic Circle. However, further concentration on the group, especially by trapping and rearing, should increase the total a little, especially in the more congenial areas such as northern Norway (influenced by the Gulf Stream Drift—*vide* results in Basden & Harnden, *in press*), and in the larger coastal settlements.

The most northerly point recorded, lat. 70° 40′ N., for *Chymomyza albopunctata*, is the only one that might lie within the real Arctic as defined by Polunin (1951, fig. 1). The other places are within tree zones and would not be considered Arctic.

The *family* is obviously not well adapted to the conditions within the Arctic Circle, since only one of the eight cosmopolitan species, *D. funebris*, is found there and none of the twenty-three species that does occur is "arctic" in the sense of being more or less confined there. In fact the reverse is the case, since all, except perhaps one, range far to the south, the most northerly species of them being *C. argyreator* and *S. teinoptera*, which are not yet known south of Finland. The exception is *C. albopunctata*, of which only one female was originally taken ; it is considered by Duda (1934 : 46), however, to be probably a synonym of a southern species.

The scarcity of Drosophilidae in the arctic and of their higher numbers southwards are indicated by the following figures. de Meijere's (1910) excellent compilation of the known Diptera of all the arctic islands (including Iceland) is not included below as it is outdated. He lists 317 species plus some to genus only, and mentions (p. 18) Drosophilidae amongst the families that appear to be wholly absent from arctic islands.

Bear Island and Spitsbergen (lat. 74° 30′–80° N.). Diptera, about 86 spp. (Thor, 1930 ; Strand, 1941). No Drosophilidae to date.

Bear Island (lat. 74° 30′ N.). Diptera, 44 spp. (Edwards, 1935). No Drosophilidae to date.

Novaya Zemlya (lat. 70° 30′–77° N.). Diptera, 144 spp. (Økland, 1928). No Drosophilidae to date.

Jan Mayen (lat. 71° N.). Diptera, 21 spp. (Bristowe, 1925) ; Macfadyen (1954) adds one more species. No Drosophilidae to date.

Greenland (lat. 60°–83° 30′ N.). Diptera, 278 spp. (Henriksen, 1939). One drosophilid known to date, *D. funebris* (Fabr.) (Vibe, 1950).

Finland (lat. 60°–70° N.). Diptera, 3824 spp.; Drosophilidae, 27 spp. and vars. (12 *Drosophila*) (Frey *et al.*, 1941 : 25). There are now 35 species (15 *Drosophila*) (Hackman, 1954, 1955.)

NORWAY (lat. 58°–71° N.). Diptera, about 2350 spp. (Soot-Ryen, 1943 : 4) ; Drosophilidae to 1940, doubtfully 19 spp. To date I have seen specimens of 13 further species (Inst. Genet. Oslo ; Univ. Zool. Mus., Oslo; Basden & Harnden, *in press*), and there is the unconfirmed record (*antea* p. 9) of *D. subobscura*.

SWEDEN (lat. 55° 30′–69° N.). Diptera, about 3740 spp. (Gislén, 1940) ; Drosophilidae, *sensu strict.*, 20 spp. (9 *Drosophila*) (Wahlgren, 1927). Wahlgren omitted several Zetterstedt (1840–1860) records, including *Geomyza* (= *Scaptomyza*) *unipunctum*. To date I have seen 19 more species (13 *Drosophila*) (Zool. Inst., Lund ; Genet. Inst., Stockholm ; coll. O. Ringdahl). The Zetterstedt and Fallén (1823) collections are being examined in collaboration with P. Ardö and R. Malaise. This examination may increase the total.

ICELAND (lat. 63° 30′–66° 30′ N.). Diptera, 241 spp. (190 spp. excluding Ceratopogonidae and Chironomidae) ; Drosophilidae, 2 spp. (Lindroth, 1931 : 316). The latest figures are 218 Diptera (excluding Ceratopogonidae and Chironomidae) with 3 Drosophilidae (Nielsen *et al.*, 1954 : 102). The 3 species are *Drosophila funebris*, *Scaptomyza graminum*, and *Parascaptomyza disticha* (sensu Basden, 1954*a*). Specimens of the last 2 species have been checked by me, by courtesy of S. L. Tuxen, they being included in *S. graminum* by Nielsen *et al.*

BRITISH ISLES (lat. 50°–61° N.). Diptera 5222 spp. ; Drosophilidae, 32 spp. (18 *Drosophila*) (Kloet & Hincks, 1945 : 400, 433). To date there are now 47 spp. (29 *Drosophila*) (Basden, 1952, 1954*a* ; Collin, 1952, 1953)—*D. polychaeta* not being included (Sobels and Basden, 1953).

DENMARK (lat. 55°–57° 30′ N.). Drosophilidae, 31 spp. (22 *Drosophila*) (O. Frydenberg, *in litt.*, 28th September, 1954).

NETHERLANDS (lat. 51°–53° 30′ N.). *Drosophila*, 24 spp. (Sobels *et al.*, 1954).

SWITZERLAND (lat. 46°–48° N.). *Drosophila*, 29 spp. (including *Obscura* X = *D. silvestris* Bas. (Burla, 1951) and excluding *D. grischuna* Burl.).

FRENCH WEST AFRICA (lat. 5°–6° N.). Drosophilidae, 96 spp. (50 *Drosophila*), in three months' collecting (Burla, 1954).

It would seem that the arctic islands are not inhabited by Drosophilidae, so the conditions that obtain there would be a barrier to population exchange by an arctic route.

A little is known of the natural history conditions or distribution of Diptera under arctic conditions from the writings of Bertram (1935), Carpenter, Collin, Degerbøl (1937), Frey (1915), Gerstäcker and Pansch (1874), Holdhaus (1927–8), Johansen (1910, 1921), Longstaff (1932), Nielsen (1910), Spärck (1943), Stackelberg (1944), Summerhayes and Elton (1923, 1928), Wahlgren (1920), and others (*vide* References). Of the Drosophilidae, the very few published notes on habitats are included in the foregoing list of arctic species ; and Basden & Harnden (*in press*) give more particulars of habitats and abundance in Norway. But many aspects of their biology remain unknown, such as breeding sites, the effect of perpetual daylight, and the resistance to winter cold.

Species that rely upon trees or scrub for sustenance or shelter will obviously exist only where the trees grow, and their distribution will not extend much beyond lat. 70° N. Excellent maps of the northern limits for conifers are given in Hustich (1953), and of all plants in N.W. Europe in Hultén (1950). Other *Drosophila* can be independent of actual trees for food, e.g. the larvae of *D. transversa* feed in fungi, and Ferdinandsen (1910) collected toadstools beyond lat. 76° N. One specimen of ? *Russula* sp. had the flesh almost entirely eaten

away by larvae when found. I do not suggest here that the larvae were drosophilid, but the record shows that development may be possible in such a medium at that latitude.

Again, the leaf-mining *Scaptomyza graminum* (sensu Basden, 1954*a* : 646) might range northwards co-extensively with the host plant, chickweed (*Stellaria media*), to at least lat. 71° N. (Hultén, 1950 ; map 682). Another recorded host plant, of *Scaptomyza apicalis* (= *flaveola*), is *Cochlearia officinalis* agg. (Frost, 1924 : 167). This grows in Spitzbergen and Bear Island (Summerhayes and Elton : 1923, 1928) and along the Alaskan arctic coast (Johansen, 1921 : 14K), and it is widely distributed across the Holarctic (Polunin, 1954 : 96). Since other recorded hosts of *Scaptomyza* grow in both Europe and North America, it is tempting to suggest that such plants could be the stepping-stones for a drosophilid from the one region to the other. There is as yet no evidence of this.

Wild berries occur far north (Ostenfeld and Lundager, 1910 : 29, 30) ; and D. Dorward tells me he found eleven species of succulent or semi-succulent fruits at Rosta, Norway (lat. 69° N.) during July and August, 1953, most of them being abundant. It has been suggested that wild fruits may be suitable as a natural breeding medium for some *Drosophila* species (Basden, 1954*a* : 614), more particularly it should be added when they are decaying on the ground, but it is not now considered that they will be of much significance in northern regions. In Scotland most overwintering female *Drosophila* are not in breeding condition during the main ripe-fruit season (Basden, 1954*b*, and unpublished), so the inability to utilise efficiently this medium doubtless applies also within the Arctic Circle.

In congenial climes the environments suitable to the larva and to the adult normally co-exist or are co-adjacent (and not readily distinguished) and allow the species to survive there. But in parts of the arctic these two conditions may be more or less completely separated so that conditions bearable to the larva may not be tolerated by the adult, or vice versa, and the species could not then survive in such a split environment. Even if the environment were otherwise suitable, the arctic climate at some time of the year may be too hostile for survival, though up to a point an inclement climate may be endured by resting or hibernating in the shelter available ; by extending the life-cycle beyond one season ; by going into diapause ; and in other ways.

Grass tussocks are well known hibernation quarters for many adult insects. O. W. Richards has taken *Drosophila fenestrarum* in tufts of *Deschampsia caespitosa* during February and March at Bagley Wood, Oxford ; and Parmenter (1950 : 125) found it in April in a *Juncus* clump on Bookham Common, Surrey. *D. caespitosa* is known to extend all over the Arctic (Polunin, 1954 : 94), as does *Juncus* and other tussock-forming plants.

Those insects (? Drosophilidae) that would hibernate in moss (Johansen, 1921 : 11K–16K), or in vegetable litter, or in the ground might become insulated against extreme cold or sharp variations of weather, by a thick blanket of snow, as quoted by Bertram (1935). The wet from the thawing of the snow, however, might be extremely dangerous, and Johansen (1921 : 8K) says, " The main objective of the hibernating insects is to find, before the snow and frost come, some place where the spring water can best be avoided ".

Another method of overcoming the conditions, especially farther north where the summer is much shorter and the temperature lower, is for development to

spread over two (? or more) years instead of one. A two-year growth period is reported for larvae of *Tipula arctica* Curtis (Diptera) at 76° 46′ N. (Nielsen, 1910) and for other insects.

The study of diapause in arctic-breeding insects seems to have been entirely neglected. Perhaps all such species there inherit this trait (obligate diapause) for, as Andrewartha introduces his paper (1952 : 50), " Diapause is an important adaptation in insects . . . enabling them to persist in regions which would otherwise be unfavourable for permanent habitation ". Basden (1954*b*) has summarised the little information on diapause in temperate *Drosophila*, but work needs to be done on the genetics, and ecological significance, of diapause in different geographical populations. It must be remembered, however, that *there is as yet no published record of a drosophilid breeding within the Arctic Circle much less within the real Arctic.* This alone indicates how little is known of the biology and habits of Drosophilidae in the cold north.

If the climate in the arctic does become milder, as indicated by the recession of glaciers, then drosophilids can be expected to spread farther north. The recent first occurrence of *D. funebris* in Greenland (Vibe, 1950), where insects had previously been extensively collected (Henriksen, 1939; Henriksen & Lundbeck, 1917) may be a case in point, though more likely to be an ephemeral introduction by man.

6. Summary.

1. The number of species of all genera of Drosophilidae recorded as common to the Palaearctic and Nearctic regions is probably twenty-two (Tables I, II).

2. Notes are given to illustrate the confused synonymy of some of these species (p. 5).

3. Eight of these twenty-two " Holarctic " species occur north of the Arctic Circle (Tables I, II).

4. The total number of species captured within the Arctic Circle is twenty-three, all from the Palaearctic region (pp.6–9).

5. Reasons are suggested why a few common species of *Drosophila* have not been found north of the Arctic Circle.

6. Very little is known respecting the natural history or true distribution of species in the arctic, and relevant aspects are discussed.

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