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CONTENTS.

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VOL. 15 JUNE 1962 PART I

The Gall Midges (Diptera : Cecidomyidae) of Wild Ox-eye Daisy (*Chrysanthemum leucanthemum* L.) Flowers, with the Description of a New Species

By H. F. Barnes*, Margaret K. Arnold and G. W. Heath

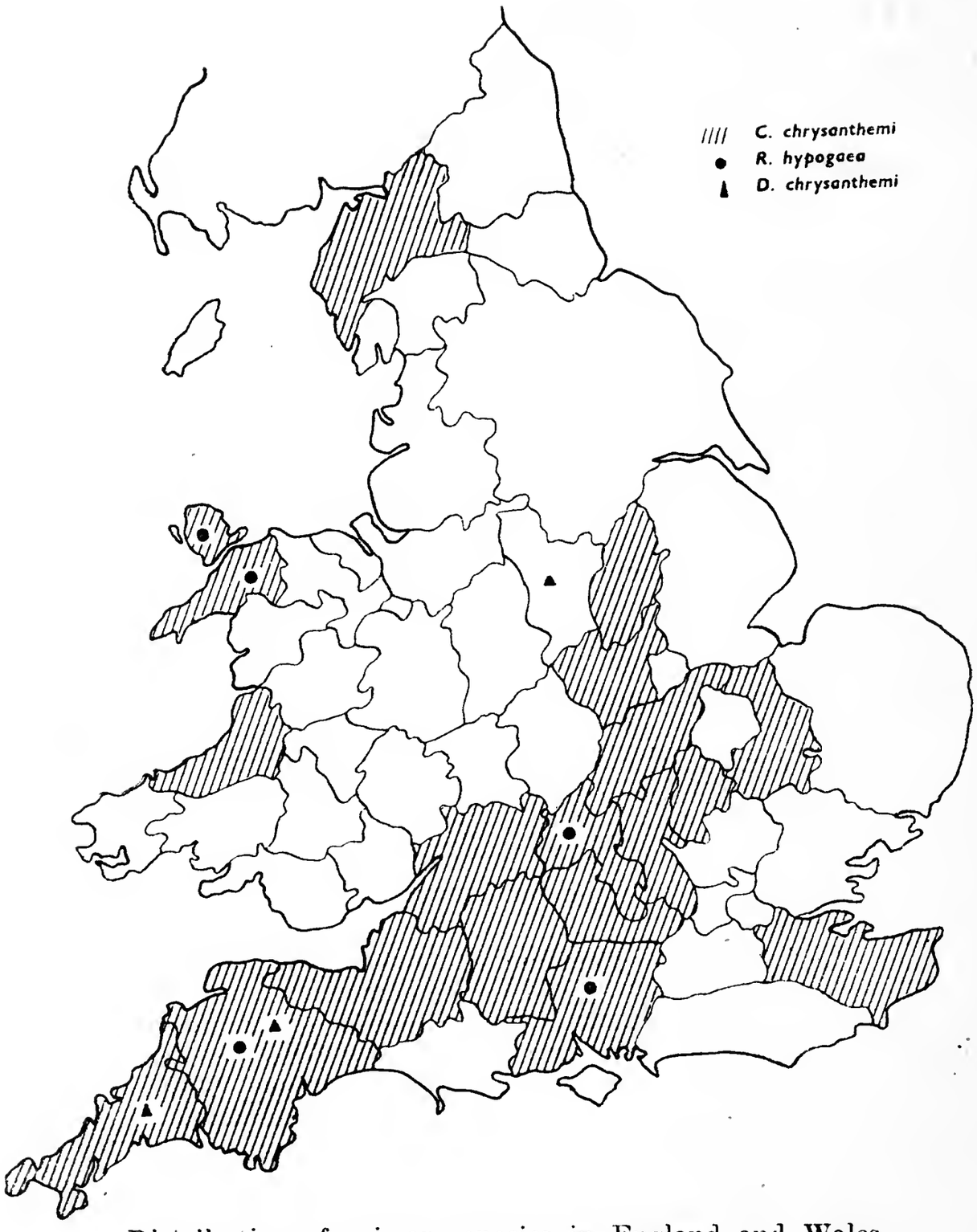
(Rothamsted Experimental Station, Herts.)

Ox-eye Daisy (*Chrysanthemum leucanthemum* L.), also known as Dog Daisy or Moon Daisy, occurs in meadows, on waste places, chalk hills and especially railway banks. Native to Europe, Siberia and the Caucasus, it is an adventive in N. America, where the species and the variety *pinnatifidum* are recognised as major weeds of grasslands in the north-east. Other names for this plant in Canada are White-weed and Marguerite.

Cohen (1952) reported on the occurrence in 1951, in the north of England, of gall midge larvae (*Contarinia chrysanthemi* Kieffer) causing havoc to the flower buds of Shasta Daisy (*Chrysanthemum maximum* Raymond). This led to an investigation of the gall midge fauna of Ox-eye Daisy flowers as the likely source of this and other possible gall midge pests of cultivated *Chrysanthemum* species. During the summers of 1952 and 1953 samples of cut flower heads of wild Ox-eye Daisies were received from many parts of the British Isles. These were placed either in 'detector' cages or in emergence pots, or both. The flower heads could not be kept alive, thus midges emerged only from flowers in which the larvae were almost full grown, when the sample was collected. The results of these surveys have been reported (Barnes, 1953a and b, and 1958b).

The purpose of this paper is to discuss the gall midges now known to inhabit the flowers of this common weed, and to describe one of them. Four of them, *Clinorrhyncha leucanthemi* Kieffer, *Dasyneura chrysanthemi* sp.n., *Rhopalomyia hypogaea* F. Loew and *Contarinia chrysanthemi* Kieffer, are primary, that is to say their larvae feed on the plant tissue. One, *Clinodiplosis* sp., is an inquiline with one or more of the primary species, and the larvae of another, *Lestodiplosis* sp., are predatory on the other gall midge larvae. The remaining species, *Phaenobremia* sp., occurs in the flower heads when aphids are present, for its larvae are aphidivorous. Species identification of these three midges, as they are of only secondary importance, is not considered necessary in this paper.

*This paper was left incomplete when Dr. Barnes died on 5th February, 1960.



Distribution of primary species in England and Wales.

Keys for the separation of the midges

The following key can be used to separate gall midges reared from the flower heads of wild Ox-eye Daisy. Separate keys are provided for the two sexes. Reference should be made to the text-figures.

Males

a Mouthparts prolonged. — *Clinorrhyncha leucanthemi* Keiffer

aa Mouthparts normal, not prolonged,

b Flagellar antennal segments not binodose.

c Palps with four segments usually, sometimes three; claws toothed; third vein not reaching tip or apex of wing. — *Dasyneura chrysanthemi* **sp.n.** [Heath]

cc Palps with one or two segments; claws simple; third vein reaching tip of wing. — *Rhopalomyia hypogaea* F. Loew

bb Flagellar antennal segments binodose.

c Nodes of flagellar segments equal, one circumfilum on each node; claws all simple. — *Contarinia chrysanthemi* Kieffer

cc Nodes of flagellar segments not equal, three circumfila.

d At least one loop of one circumfilum and one seta greatly produced; claws on fore-legs toothed. — *Phaenobremia* sp.

dd No loop of circumfilum and no seta greatly produced.

e Basal clasp segment of male genitalia not lobed; ventral plate emarginate distally; claws on fore-legs toothed; wings clear, not mottled. — *Clinodiplosis* sp.

ee Basal clasp segment lobed at the base; ventral plate short and rounded; claws all simple; wings usually mottled. — *Lestodiplosis* sp.

Females

a	Mouthparts prolonged.	*Clinorrhyncha leucanthemi* Kieffer
aa	Mouthparts normal, not prolonged.	
	b Ovipositor aciculate or needle-shaped, with two minute distal lamellae.	*Contarinia chrysanthemi* Kieffer
	bb Ovipositor pocket-shaped.	
	c Palps with four segments usually, sometimes three; claws toothed.	*Dasyneura chrysanthemi* **sp.n.**
	cc Palps with one or two segments; claws simple.	*Rhopalomyia hypogaea* F. Loew
	bbb Ovipositor lamelliform.	
	c Wings clear, not mottled; claws on fore-legs toothed.	
	d Claws bent at right angles.	*Clinodiplosis* sp.
	dd Claws evenly curved.	*Phaenobremia* sp.
	cc Wings usually mottled; claws all simple; dark spot inside abdomen.	*Lestodiplosis* sp.

It should be pointed out that, as the species living in the flower heads of this weed all belong to separate genera, they should not be difficult to identify. However, these keys are only intended to be used to identify midges from Ox-eye Daisy.

Clinorrhyncha leucanthemi Kieffer (Fig. 1a)

This midge is easily recognised as belonging to the tribe Lasiopterariae because of the close approximation of the costa, subcosta and third vein which are heavily scaled and end well before the tip or apex of the wing. The abdomen is thickly clothed with dark and white scales and the flagellar antennal segments are short and sessile in both sexes, with the circumfila being applied and not forming loops. The genus is also readily identified as *Clinorrhyncha* H. Loew because of the greatly prolonged mouthparts and the forked fifth vein, although the latter is sometimes scarcely visible.

It is more difficult to be sure of the species. The type of the genus is *C. chrysanthemi* H. Loew, 1850, described inadequately for specific recognition, but stated to live in the flowers of "*Chrys. inod.*" (now known as *Matricaria maritima* L. subsp. *inodora* L., Scented Mayweed) and "*Anth. arv.*" (*Anthemis arvensis* L., Corn Chamomile). The following species from known host plants have also been described in Europe: —

C. millefolii Wachtl, 1884, on *Achillea millefolium* L. (Yarrow).
C. tanaceti Kieffer, 1889, on *Tanacetum vulgare* L. (Tansy).
C. leucanthemi Kieffer, 1890, on *Chrysanthemum leucanthemum* L. (Ox-eye Daisy).
C. anthemidis Rübs., 1915, on *Anthemis arvensis* L. and *A. tinctori* L. (Corn and Yellow Chamomile).

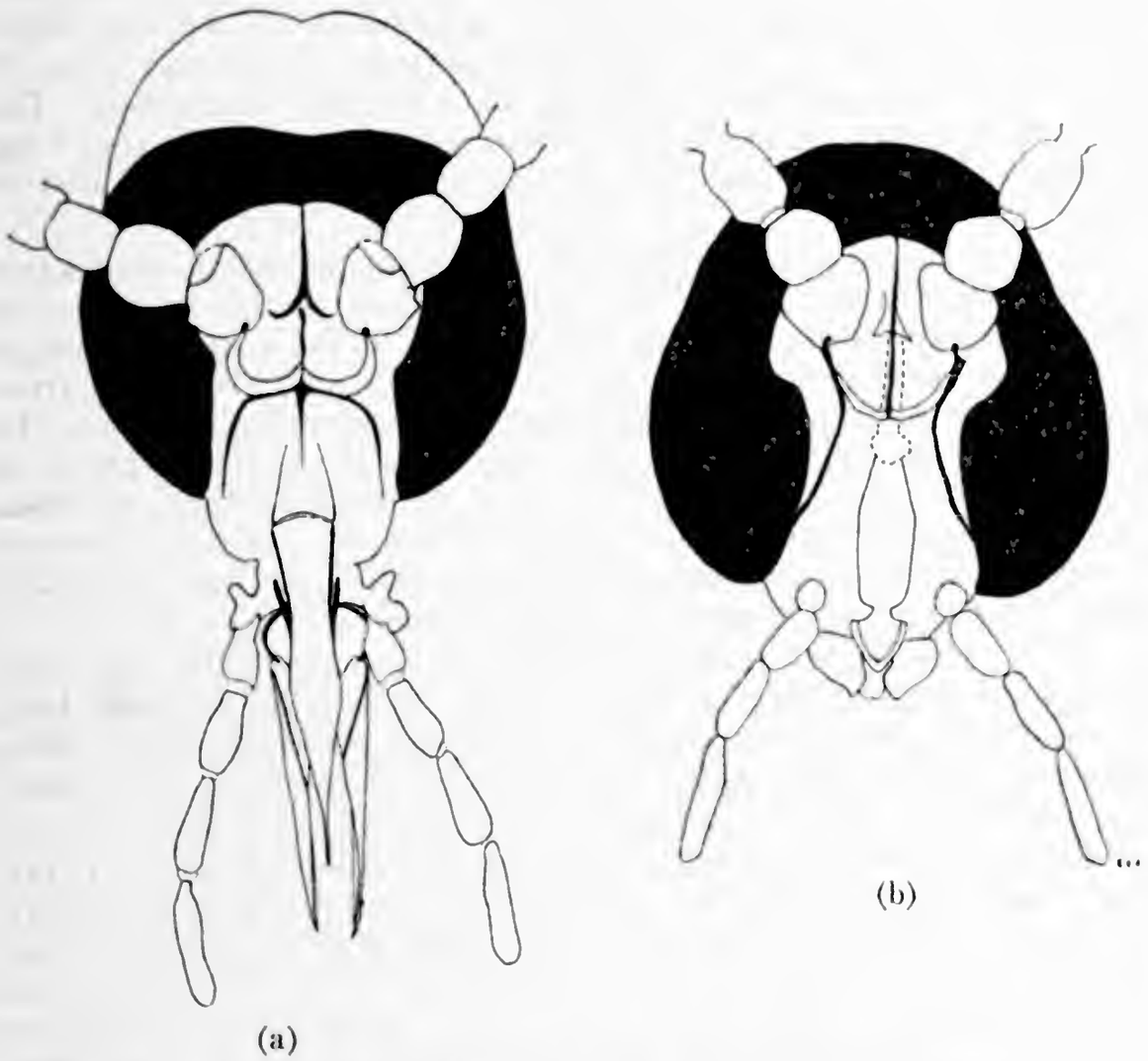


Fig. 1.—(a) *Clinorrhyncha* head; (b) *Dasyneura* head.

Apparently Rübsaamen was not convinced that *C. chrysanthemi* did occur on *Anthemis* and so described *C. anthemidis* as the species occurring on *Anthemis*, leaving *C. chrysanthemi* as the species on *Matricaria*. He also did not mention *C. leucanthemi* Kieffer in his list of German species (Rübsaamen and Hedicke, 1925-39). Rübsaamen separated *C. anthemidis* from *C. millefolii*, *C. chrysanthemi* and *C. tanaceti* because it has 2 + 12, rarely 2 + 11, antennal segments, whereas the other three species have 2 + 8-10. *C. millefolii* he stated has 2 + 8 antennal segments, brass-yellow hairs on the thorax and thickened femora and tibiae, whereas *C. chrysanthemi* and *C. tanaceti* have 2 + 8-10 antennal segments, no such hairs on the thorax and no swollen femora and tibiae. These last two species he separated because the third vein

(radius) ends before the middle of the wing in *C. chrysanthemi* and after the middle of the wing in *C. tanaceti.* Möhn (1955) describes and figures the larvae of *C. millefolii* and *C. anthemidis.*

What is recognised here as *C. leucanthemi* Kieffer, largely because the specimens have been reared on *Chrysanthemum leucanthemum, C. balsamita, C. cassium, C. marschallii, C. parthenium* or *C. roseum,* has the following relevant characters. The most usual number of antennal segments is 2 + 10, but slight variation (2 + 9-11) has been found, which lessens the value of the number of antennal segments as a specific character. The third vein joins the costa at about half way along the wing margin. The tibiae and femora are not appreciably swollen in either sex.

It thus seems apparent that there are no clear-cut characters for the separation of the species and that reliance has to be placed largely on the host plants. A study of the host plant range of the five species, and attempts to cross individuals reared from the various host plants, might throw considerable light on the validity or otherwise of the species forming this discrete group of gall midges restricted in Europe to *Matricaria, Achillea, Tanacetum, Chrysanthemum* and *Anthemis.* One additional European species, *C. crassipes* Winnertz, 1853, has been described from 2 males and 1 female caught in a meadow.

In N. America, *C. millefolii* Wachtl (confirmed by Kieffer) has been bred from Yarrow, and *C. eupatoriflorae* Felt, 1908, from flowers of *Eupatorium perfoliatum* (Thoroughwort). Two other species, *C. filicis* Felt, 1907, and *C. karnerensis* Felt, 1907, have been described from caught specimens.

Clinorrhyncha leucanthemi Kieffer has been recorded on Ox-eye Daisy from Durham, Northumberland and Scotland by Bagnall and Harrison (1918), but otherwise it has not been recorded, perhaps because it does not make an obvious gall, its larvae living in the swollen achenes. An individual was found on 19th June, 1926, ovipositing on wild Ox-eye Daisy at Wisley, Surrey. A female was also reared on 20th July, 1954, from a sample of wild Ox-eye Daisy flower heads collected by H. F. Tebbs, on 23rd July the previous year at Ufford and Barnack Station, Lincolnshire (H. F. B.). It was not obtained from any other of the many samples of this weed received during 1952-4. This may have been because most of the samples were collected rather too early in the season to contain well-grown larvae.

Samples of other *Chrysanthemum* species were more productive. From samples of *C. cassium* Nábelek, *parthenium* and *roseum* Adam, collected at Wisley, Surrey on 13th July 1953, *Clinorrhyncha leucathemi* Kieffer emerged between 4-13th August, 1953. Also samples of *C. balsamita* Linn., *cassium* and *marschalli* Aschers, collected at Bayfordbury, Herts., on 30th July, 1953, produced *C. leucanthemi* midges between 4th August-1st September, 1953.

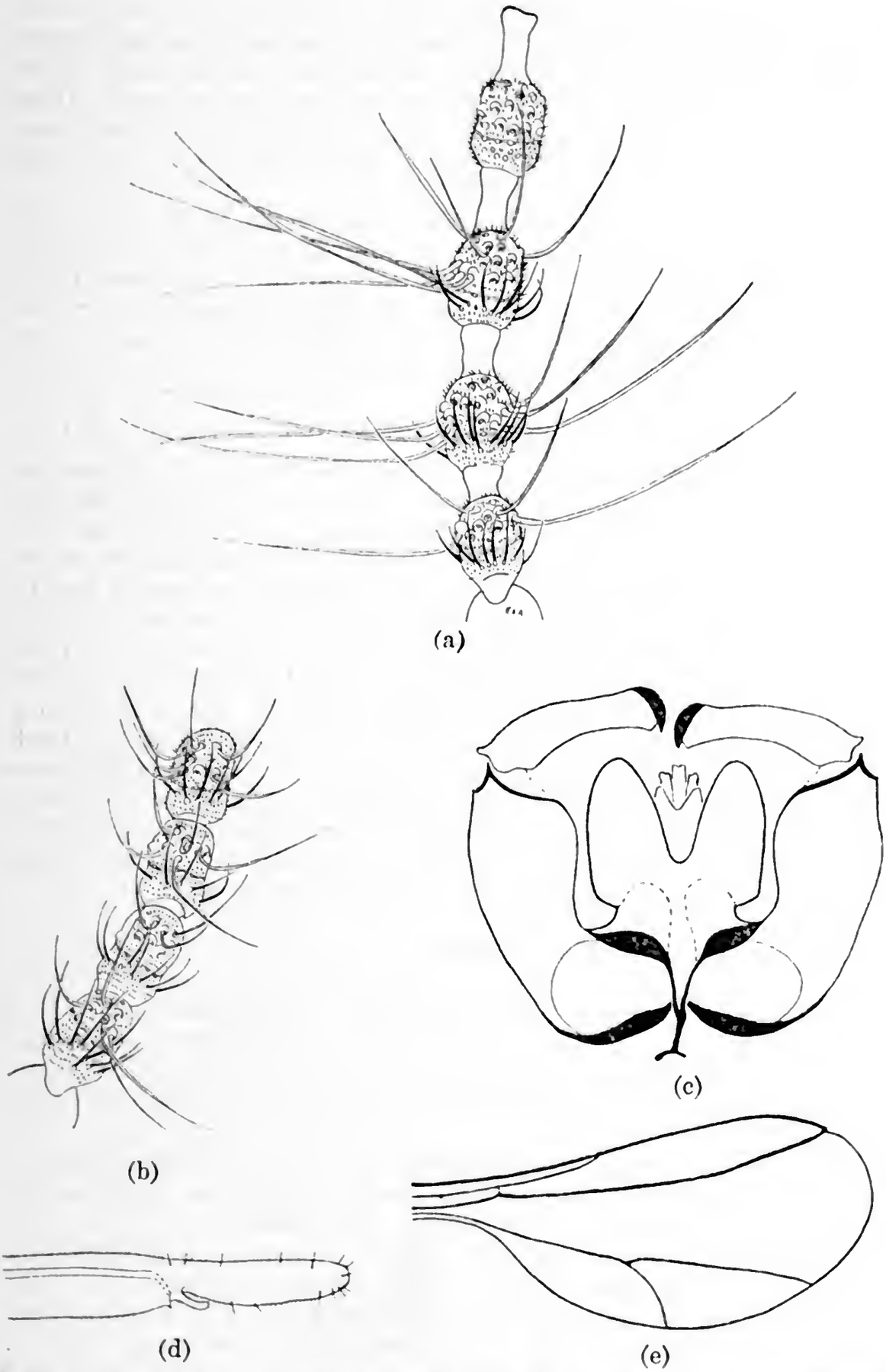


Fig. 2.—*Dasyneura chrysanthemi* sp.n.: (a) ♂ antenna (1st-4th flagellar segments); (b) ♀ antenna (1st-4th flagellar segments); (c) ♂ genitalia; (d) ovipositor; (e) wing.

The biology of this species has not been studied in any detail. There may be one or two generations a year, but it is not known on what plants the larvae of a second generation could live. It is clear, however, that pupation occurs in the flower heads, from whence the current year's midges emerge, though doubtless those overwintering fall to the ground as the flowers dry and disintegrate.

No attempts were made to transfer *C. leucanthemi* from its wild host plant, Ox-eye Daisy, to any of the five cultivated *Chrysanthemum* species mentioned above but the host plant range of *Clinorrhynca leucanthemi* Kieffer is considered to be *Chrysanthemum leucanthemum, C. balsamita, C. cassium, C. marschallii, C. parthenium,* and *C. roseum.*

Dasyneura chrysanthemi **sp.n.** [Heath] (Figs. 1b, 2a-e, and 4a)

This midge is a typical member of the tribe Dasyneurariae, with the third vein well separated from the costa, the flagellar antennal segments having a length greater than their diameter, cylindric and not binodose in the male, and the claws toothed. In Felt's key (1925) it runs down to the genus *Dasyneura* having quadriarticulate palpi, antennae with usually 14 or more segments, the third vein uniting with the costa well before the apex of the wing, the claws on all the legs being toothed, the wing veins not distinctly scaled, the membrane hyaline and the fifth vein forked.

Except for the very doubtful *D. francoisi* Kieffer, 1901, described on the gall only from *Achillea millefolium,* no species of *Dasyneura* has been recorded from *Chrysanthemum* or closely allied genera of plants. As something is known about its biology, it is advisable to describe the *Dasyneura* reared from wild Ox-eye Daisy as a new species, *Dasyneura chrysanthemi* sp.n.

Dasyneura chrysanthemi **sp.n.**

Male

Average body length: 1·0 mm. Head: Antennae 2 + 12 to 2 + 15. Width of node of the third flagellar segment about half the length of segment. Nodes bear a whorl of stout setae basally and a group of about 20 tubercle-based longer setae apically and anteriorly.

Thorax: Wings hairy, fifth vein forked with posterior arm curving to meet the margin almost at right angles. Anterior arm branching at an angle to the curve of the posterior arm.

Abdomen: Basal clasp segment of the male genitalia prominently constricted at its base. Distal clasp segment neither narrowing nor broadening but of equal width throughout. Dorsal plate constricted at its base, lobes narrowly rounded and deeply emarginate. Ventral plate shorter with lobes slightly truncated at tips, a little more widely and about half as deeply emarginate as the dorsal plate. Base of harpes setose, stout and rounded, harpes digitiform apically. Style about same length as dorsal plate.

Female

Average body length: 1·0 mm. Head: Node of third flagellar segment a little longer than wide, about 7-11 tubercle-based setae apically and anteriorly.

Thorax: Empodium a little longer than claws.

Abdomen: Ovipositor, the terminal lobe only a little narrower than the remainder of the ovipositor.

Types Cecid. 8266 ♂ and 8289 ♀ and Cotypes Cecid. 8258 ♂, 8262 ♀, 8276 ♀ in the Barnes Collection in the British Museum (Natural History).

The number of antennal segments varies as is common in *Dasyneura* species. In sixteen males the number varied from 2 + 12 to 2 + 15; in twenty females it varied from 2 + 10 to 2 + 14. There is the usual positive correlation of general size of midge and number of antennal segments.

Fig. 3.—♂ antenna of *Contarinia* (3rd and 4th flagellar segments).

This species seems to be abundant on wild Ox-eye Daisy in Jersey, and common in Devon and Cornwall in England. It appeared in one Derbyshire sample, and one larva possibly of this species occurred in each of two samples, one from Cumberland and one from East Lothian.

Some midges emerged the same year as the samples were collected, but more emerged the following year from all samples. (See table 1.)

TABLE 1

Emergence dates of *D. chrysanthemi*

Locality	*Emergence Dates*	
	1952	1953
Starcross, Devon	19 July-8 September	6 June- 4 July
Bonne Nuit, Jersey	7 July-5 September	19 May- 3 July
Bourlay Bay, Jersey	6 July-3 September	20 May-23 July

All three samples were collected in June 1952.

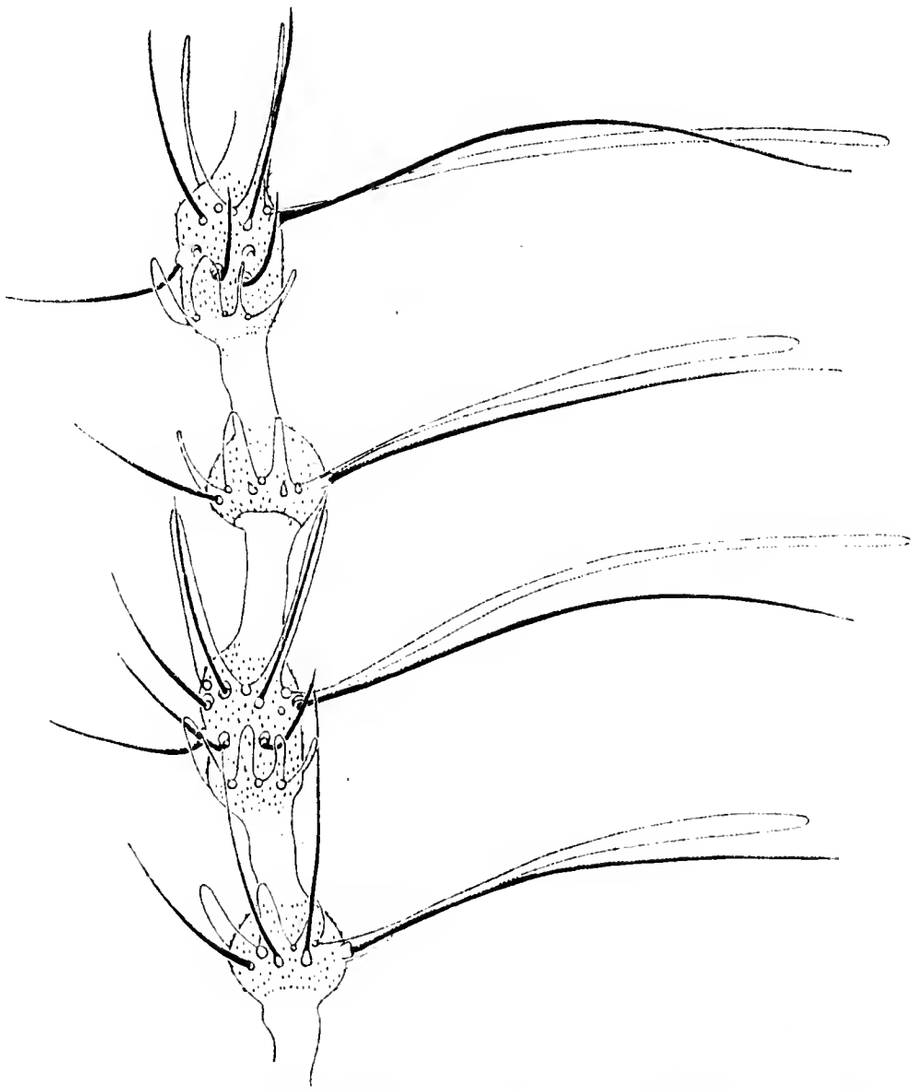


Fig. 3.—♂ antenna of *Phaenobremia* (2nd and 3rd flagellar segments).

The life history of this midge may be summarised as follows: there are one or two generations a year; the spring flight, which is made up of individuals of two different generations, occurs in

May and June; eggs are laid in the open flowers of wild Ox-eye Daisy; after they finish feeding, the pink larvae leave the flower heads and pupate in the soil; some individuals complete their life-cycle in 39-40 days, first appearing on the wing in early July, thus sometimes overlapping the last individuals of the spring flight; this second or summer flight is very extended, individuals continuing to emerge until early September; presumably a second generation occurs in flowers of *Chrysanthemum* species which are still available; other individuals take much longer to complete their cycle, and do not fly until the following May and June.

Fig. 3.—♂ antenna of *Clinodiplosis* (2nd and 3rd flagellar segments).

A few host-plant tests were made with some of the midges reared from Ox-eye Daisy. Egg-laying was observed on *C. arcticum* L., *C. maximum* Raymond, var. "Esther Read", *C. cinerariaefolium* Vis., and *C. maximum* L., var. "Mount Everest", but not on *C. carinatum* L., and *Bellis perennis* L. It is obvious

that *Dasyneura chrysanthemi*, discovered on wild Ox-eye Daisy, may well become a pest on cultivated *Chrysanthemum* species, especially on "Esther Read" the variety of *C. maximum* on which it breeds readily.

Rhopalomyia hypogaea F. Loew (Figs. 4b and 5a)

This midge belongs to the tribe Oligotrophariae which, although possessing the third vein well separated from the costa and the flagellar antennal segments with a length greater than their diameter, cylindric and not binodose in the male, is separated from the Dasyneurariae by Felt because the claws are simple and not toothed. The flagellar antennal segments, although cylindric or subcylindric, are not greatly elongated and usually have a distinct neck in the male thus affording a diagnostic difference from the tribe Asphondylariae, in which the flagellar segments are cylindric, elongate and sessile. The ovipositor of Asphondylariae is usually needle-shaped, whereas in the Oligotrophariae it is not.

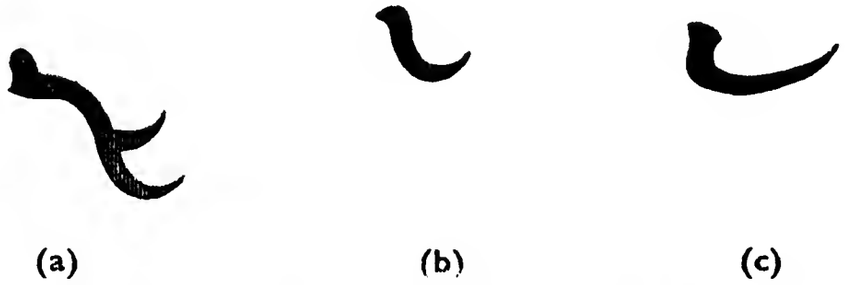


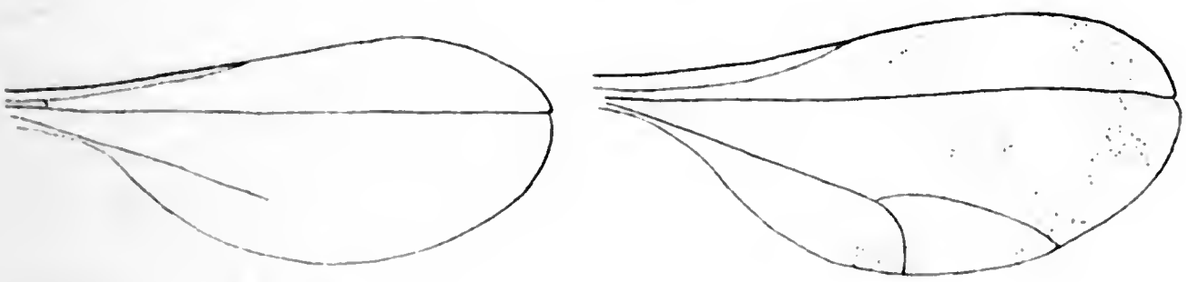
Fig. 4.—Claws of (a) *Dasyneura*, (b) *Rhopalomyia*, (c) *Clinodiplosis*.

Continuing Felt's keys, this midge falls in the group of genera possessing one or two palp segments; whose ovipositor is not distinctly sclerotinized; whose pulvilli are distinctly shorter than the empodium, which is as long as, or longer than, the claws; which does not have an unusually large third flagellar antennal segment; whose terminal clasp segment is large, swollen and only slightly constricted distally; and whose ovipositor is pocket-shaped.

Thereafter it is difficult to place this species, which was originally described in the genus *Cecidomyia* by F. Loew (1885). Rübsaamen (1915) placed it in the genus *Rhopalomyia* which he separated from *Misospatha* because its females possess flagellar segments with necks and reticulated circumfila, whereas *Misospatha* females have sessile flagellar segments without necks and the circumfila do not form reticulations. Kieffer (1913), although he used almost the same characters, placed *hypogaea* F. Loew in the genus *Misospatha*. With only *hypogaea* F. Loew, *ptarmicae* Vallot, *californica* Felt and *millefolii* H. Loew available for examination, it seems preferable to place *hypogaea* F. Loew in the genus *Rhopalomyia* with the reservation that the delimitation of the genera *Rhopalomyia* and *Misospatha* is not altogether

satisfactory, particularly because Rübsaamen placed *hypogaea, ptarmicae* and *millefolii* in *Rhopalomyia,* whereas Kieffer places *millefolii* in *Rhopalomyia* and *hypogaea, ptarmicae* and *californica* in *Misospatha* although Felt described *californica* in the genus *Rhopalomyia.*

The specimens considered to be *hypogaea* F. Loew in the Barnes Collection were all reared from the flower heads of wild Ox-eye Daisy and have the following relevant characters. Most of the twenty-three specimens have one palp segment although at least five of the eighteen females have two. The antennae are 2 + 14, but in slightly over half the specimens the two terminal segments are not completely separated, giving the appearance of an extra long terminal segment. The first and second flagellar segments are fused. The necks of the flagellar segments in the males are of medium length but distinctly shorter than the node, those in the females are short and about as long as wide. In the females the first flagellar segment is shorter than the second, thereafter the segments taper off in size. The circumfila are applied and extremely difficult to see in unstained mounts.



(a) (b)

Fig. 5.—Wings of (a) *Rhopalomyia*, (b) *Lestodiplosis.*

Seven samples of wild Ox-eye Daisy from England and Wales (two from Devon, one from Hampshire, one from Oxfordshire, one from Caernarvonshire and two from Anglesey), but none of the samples from Scotland, Ireland or Jersey contained *R. hypogaea.*

TABLE 2

Sampling dates, emergence dates, and numbers of *R. hypogaea*

County	*Sampling dates*	*Emergence dates*	*No. of midges* ♂	♀
Hampshire	6.7.52	16 July, 1952	0	1
Oxfordshire	12.6.52	23-27 June, 1952	2	1
Caernarvonshire	13.6.52	28 June-2 July, 1952	7	14
Brynsiencyn Anglesey	19.6.52	5-10 July, 1952	0	4
Newborough, Anglesey	4.6.52	23 June, 1952	0	2
Starcross, Devon	18.7.53	5 August, 1953	1	0
Prawle Point, Devon	22.8.53	27 August, 1953	0	1

Table 2 shows that the midges emerged the same year as the sample was collected and that samples collected in June, July

and August all gave rise to midges, although very few except for the Caernarvonshire sample. It can be concluded that this species is not common, but is widely scattered, that it has two generations a year, and that the midges forming the second flight of the year emerged over a long period, certainly from June-August.

No galls were detected in the wild Ox-eye Daisy flower heads, but Houard (1909) states: "Fleurs charnues, coniques, blanches ou roussâtres, faisant saillie au milieu du capitule; l'ovaire est soudé au réceptacle. Il y a atrophie partielle du capitule dans lequel les fleurs ligulées se developpent mal ou même pas du tout". *R. hypogaea* also is recorded as forming leaf-bud galls and a stem gall on *Chrysanthemum leucanthemum* in France and Italy, a stem and a leaf gall on *C. corymbosum* in France, a stem gall on *C. atratum* in central Europe, possibly a terminal gall on *C. japonicum* in France and a bud gall on *C. myconis* in France. In England Bagnall and Harrison (1921) recorded this species from Devon in October 1918 ("midges bred immediately") and in September 1920. They stated: "flowers hardened, discoloured, conical, sometimes only slightly atrophied; buds also attacked and when axillary affecting the stem".

Only two preliminary tests of host-plant range of this species were made. The first was with *C. maximum* var. "Mr. C. Lothian" and egg-laying was observed on the opening flowers; the second was with *C. carinatum* and oviposition was not observed. No midges developed on either species.

The interesting thing about this re-discovery of *R. hypogaea* F. Loew is that it was for many years considered to be the Chrysanthemum Gall Midge which makes conical galls on the leaves and stems of commercial chrysanthemums and which was identified by Felt as *Diarthronomyia hypogaea* F. Loew. Finally Ahlberg (1939) proposed the name *D. chrysanthemi* for this species of known economic importance. From an experimental study of the host-plant range of the Chrysanthemum Gall Midge, Barnes (1939) concluded that this species should be regarded as distinct and separate from *R. hypogaea* F. Loew of wild *Chrysanthemum* species. At that time living specimens of this latter species were unobtainable and so reciprocal experiments could not be attempted with it. Having now obtained specimens of *R. hypogaea,* it is obvious that *D. chrysanthemi* Ahlberg and *R. hypogaea* are distinct species. Besides differing in general appearance, *R. hypogaea* is a much more heavily built midge than *D. chrysanthemi.* The two species can be separated by the fact that *R. hypogaea* has simple claws although the tooth is difficult to see; also the stems of the flagellar segments on the females' antennae of *D. chrysanthemi* have considerably larger necks than those of *R. hypogaea.* It is, however, of considerable doubt whether the presence or absence of the minute tooth warrants the separation of the genera *Diarthronomyia* and *Rhopalomyia* into two tribes, the Dasyneurariae and Oligotrophariae respectively.

Contarinia chrysanthemi Kieffer (Figs. 3a, 6a)

This species belongs to the tribe Cecidomyariae in which the flagellar antennal segments of the males are produced and consist of two nodes and on which the circumfila usually occur as whorls of long loops. This tribe is separated by Felt into two subtribes, although some later workers consider them worthy of tribal status. This midge belongs to the first of these, the Bifila, in which the nodes are approximately of the same size and each bears one circumfilum or looped thread.

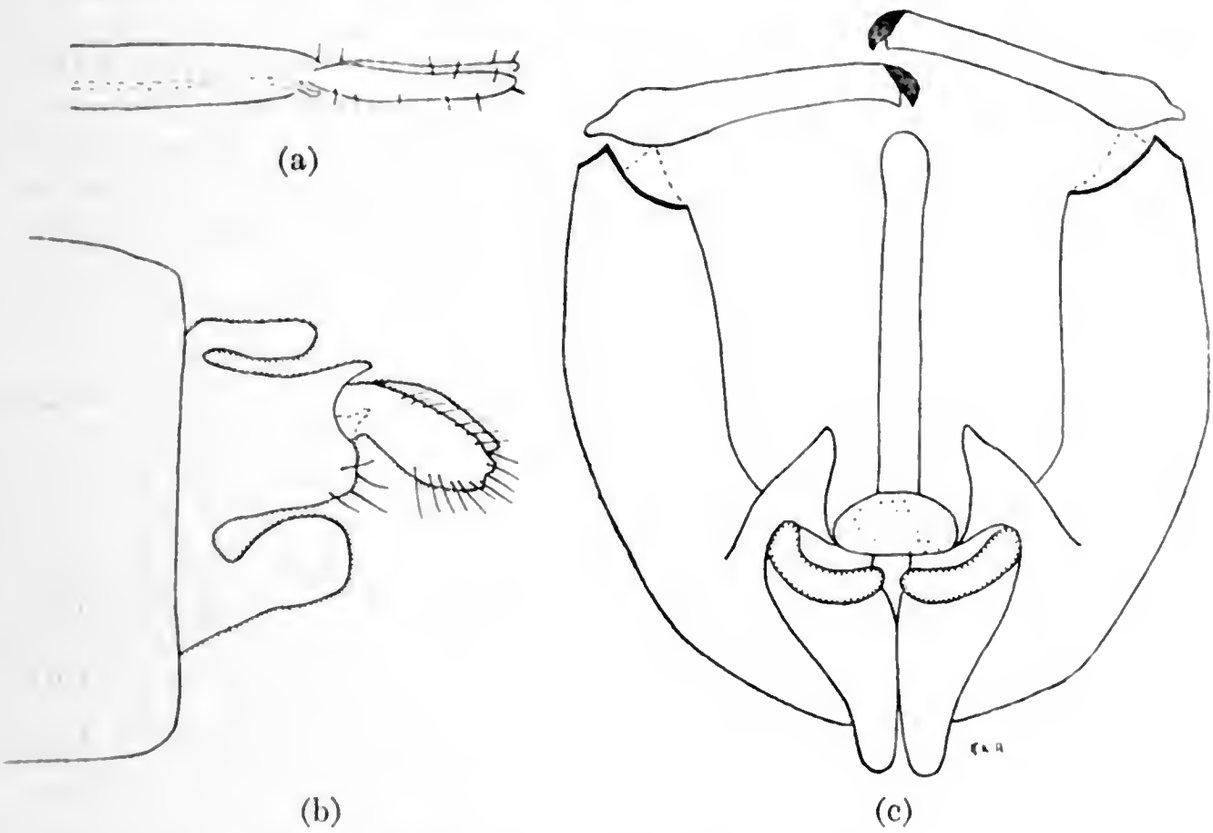


Fig. 6.—Ovipositor of (a) *Contarinia* (× 240), (b) *Phaenobremia* (× 120), (c) ♂ genitalia of *Lestodiplosis*.

It is a typical *Contarinia,* having four palp segments, all flagellar antennal segments binodose, and the claws on all the legs simple; the wings are normal, not being specially broad or narrow; the costa is not thickened basally nor clothed with scales, and the third vein unites with the margin at the apex of the wing where it interrupts the margin; the basal clasp segment is not lobed and the lower lamella is deeply bilobed; the ovipositor is long, slender, almost aciculiform, but bearing a pair of minute lamellae.

Kieffer (1895) originally described the species in his genus *Eudiplosis* which he later made a synonym of *Contarinia.* He described it thus: "*Eudiplosis chrysanthemi* n. sp. D'un rouge orange. Antennes, thorax à l'exception des côtés, bandes sur le dessus et le dessous de l'abdomen bruns. Pilosité de l'abdomen appliquée et d'un blanc argenté. Larve dans les fleurs de *Chrysanthemum leucanthemum,* entre les akènes". The colour of living specimens, especially the females, is sometimes a pastel

shade of pale orange-red, but not nearly so intense as the red of *Dasyneura* females. In some specimens, however, this colour is barely noticeable and can almost be described as a pale pink. It is never of an intensity of lemon yellow as in many other *Contarinia* species, e.g. *C. tritici*. *C. chrysanthemi* is a medium-sized *Contarinia*.

This species seems, from the sampling, to be the most common and widely spread primary species occurring in wild Ox-eye Daisy flower heads. It occurred in many of the Southern and Midland counties (see Map), also in Cumberland and parts of Wales. Although *Contarinia chrysanthemi* was first reported as a pest of Shasta Daisy in the Newcastle-on-Tyne area no midges were found on the Ox-eye Daisy samples from Northumberland. The only occurrence in the north of England was of a few larvae in the Cumberland samples of 1953. In Ireland it was recorded from the counties of Cork, Meath and Wexford. *C. chrysanthemi* did not appear in the samples from Scotland or Jersey.

TABLE 3

Emergence data for *C. chrysanthemi*

Locality	*Sampling date*	*Emergence dates* 1952	1953
Newborough, Anglesey	4.6.52	29 July-28 Aug.	1 June- 1 July
Oxford	12.6.52	—	28 May-24 June
Trowbridge, Wiltshire	26.6.52	—	14 June-17 July
Trawscoed, Cardiganshire	28.6.52	—	12 June-10 July

Most of the 1952 samples did not produce adult midges until May, June and July 1953, but midges emerged during August 1952 from an Anglesey sample (Table 3). The early summer emergence, resulting from larvae which have overwintered and pupated in the soil, gives rise to the initial and main infestation of the year. Most larvae of the main infestation overwinter in the soil to produce the first flight of the next year, but a few larvae complete the life cycle the same year to give a partial second flight in late July, August and early September. Larvae of *C. chrysanthemi* were found to spend two or more winters in the soil before emerging as midges.

Host-plant tests showed that *C. chrysanthemi* from Ox-eye Daisy will breed on *Chrysanthemum carinatum* Schousb., *C. frutescens* L., *C. maximum* L., vars. "Esther Read" and "Everest" and *Bellis perennis*. The females will also lay eggs on *C. arcticum* L., *C. cinerariaefolium* Vis. and Sweetheart Chrysanthemum. Larvae of *Contarinia chrysanthemi* were found on several other varieties and species of *Chrysanthemum* received in the 1953 survey. The results are given by Barnes 1953b and 1958b.

The three secondary species are members of the genera *Clinodiplosis, Lestodiplosis* and *Phaenobremia.* They all belong, like *Contarinia,* to the Cecidomyariae, the males having binodose flagellar antennal segments. Unlike *Contarinia,* however, these genera are members of the subtribe Trifila, because the nodes of the antennal segments are unequal in size and each segment bears three circumfila. The three types are easily separable by their generic characters, but by contrast the species are difficult to separate in the genera *Clinodiplosis, Lestodiplosis* and *Phaenobremia.*

Clinodiplosis sp. (Fig. 3c and 4c)

In common with *Lestodiplosis* and *Phaenobremia* this midge has quadriarticulate palps. The circumfila of the male are regular as in *Lestodiplosis,* but the male *Clinodiplosis* can be distinguished from *Lestodiplosis* as it has no lobe on the basal clasp segment of the genitalia. The claws are curved at right angles, and those on the anterior legs are unidentate.

Clinodiplosis sp. occurs as an inquiline with other gall midges. Its distribution is very similar to that of the primary species, midges occurring in most of the counties in which primary species occurred. *Clinodiplosis* sp. also appeared in a few counties (Monmouth, Worcestershire, Hertfordshire and Surrey) from which the primary species were not recorded. This suggests that one or more of the primary species occurred in these counties, but were probably not in the samples received because the larvae had left the flower heads before they were cut.

Clinodiplosis midges emerged from the samples, collected in June, over a period from late June to early September of the same year; and some samples gave rise to a few midges in June and July of the following year. The first generation is very extended and probably there is a second generation overlapping the first.

Lestodiplosis sp. (Figs. 5b and 6c)

This midge has quadriarticulate palps and regular circumfila. It can be distinguished from *Clinodiplosis* by its simple, evenly curved claws and by the triangular lobe on the basal clasp segment of the male. The wings are usually spotted, though they sometimes appear hyaline on specimens mounted in balsam. The larvae of *Lestodiplosis* sp. prey on other gall midge larvae and on mites. The species is widely distributed over the British Isles, occurring in most places where other midges have been recorded from Ox-eye Daisy, and elsewhere.

Lestodiplosis midges emerged from the samples of June 1952 at the end of that month until September. Only two samples produced any midges (in May and July) the following year. There is time for a second generation overlapping the prolonged first generation.

Phaenobremia sp. (Figs. 3b and 6c)

Like *Clinodiplosis* and *Lestodiplosis* this midge has quadriarticulate palps, but two circumfila on each antennal segment of the male are irregular, one or more of the loops being greatly produced. The claws are evenly curved and the anterior ones are toothed.

The *Phaenobremia* midge was bred from Ox-eye Daisy samples from Bedfordshire, Hertfordshire and Berkshire. The larvae feed on aphids, and they occur only on Ox-eye Daisy attacked by aphids.

There were too few specimens to provide any information on the life history of this species. The few midges that emerged did so in July and August.

In the experiments on host-plant range of the primary species, midges of the genera *Clinodiplosis, Lestodiplosis* and *Phaenobremia* occurred on many of the *Chrysanthemum* species and varieties tested. Their occurrence on these plants depends on the presence of one or other of the primary species, or in the case of *Phaenobremia* sp. on the presence of aphids. The association of a group of gall midge species on a part of a particular host-plant or range of host plants is not unusual. Such an association has been noted in the flowers of several plants, especially grass inflorescences, e.g. *Alopecurus pratensis* (Barnes, 1930), *Phleum pratense* (Barnes, 1958a) and clover flowers (Milne, 1960). The complex has never been found to include more than one species of any particular genus.

A *Contarinia* sp. and a *Dasyneura* sp. often occur together, the *Contarinia* in large numbers where the *Dasyneura* is solitary; other injurious genera are frequently represented, e.g. *Stenodiplosis* and *Sitodiplosis* in grass inflorescences. An inquiline *Clinodiplosis* is usually to be found, living in company with injurious species, while a predatory *Lestodiplosis* may be feeding on any of the injurious species, perhaps being beneficial to some extent (Barnes, 1948). Thus the species complex found on wild *Chrysanthemum leucanthemum* and cultivated chrysanthemums resembles that found on other plants.

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