Studies on the Classification of the
Simuliidae (Diptera).

Thesis submitted (with two supporting
papers) for the degree of Doctor of
Science in the University of Edin-
burgh, 1946, by John Smart, B.Sc.
(Agric.), Ph.D.

Copy No. 1.
The writer has been studying the Simuliidae intermittently since 1930 when, under the direction of the late Professor J.H. Aaaworth and Dr. A. H. Cameron, he was introduced to the family with a view to making it the subject of his first research project. The first approach to the family was that of the field ecologist, morphologist and anatomist. Then, however, in 1935, the writer joined the staff of the British Museum (Natural History), the Simuliidae had to take a secondary place since the particular Diptera to which his attention were directed were the Cyclorrhapha and furthermore, because the late Dr. E. A. Edwards was actively engaged in work on the Simuliidae amongst the other Hematocera of which he was in charge.

While on an expedition to British Guiana and the Lesser Antilles (with Dr. O. J. Richards) in 1937 the writer’s earlier field experience naturally led to a considerable collection of Simuliidae being made. This material was worked up with Dr. Edwards’s active encouragement and the first paper now submitted resulted. The second paper, which is in the nature of a postscript to the first, resulted from the discovery in the Museum of material thought to be lost but which came to light when the Diptera collections were being prepared for evacuation to Herefordshire as a precaution against air-raid damage during the recent war.

Owing to Dr. Edwards’s death in 1941 the writer had to take charge of the Hematocera and since this happened in the midst of the war, attention had to be concentrated on the Culicidae and other
vectors of disease but it was no longer necessary to avoid the Simuliiidae in order to prevent any possible duplication of effort.

War-time conditions prevented travel to overseas museums and also the borrowing of type- and other important material from such institutions and consequently such work as the writer could carry out on the Simuliiidae tended to be on the literature and on the British species. This resulted in the third paper, which is merely concerned with certain nomenclatural questions, and in the fourth paper which, it is believed, reports on a far fuller investigation into the literature of the Simuliiidae and their nomenclature, than any previously carried out.

Until the discovery of the transmission, by species of the family Simuliiidae, of nematode worms of the genus Onchocerca in man (1926) and cattle (1937) and of the protozoan blood-parasites of the genus Haemocystozone in ducks (1930), the Simuliiidae had drawn attention to themselves mainly by the virulent attacks of the females of some species on man and domestic stock on the blood of which the females nourished themselves. When, however, their activities as vectors was discovered, their classification and distribution became important. Many workers proceeded to take up the study of restricted faunas but any fairly wide examination of the literature will reveal at once (and see introductory remarks in the fourth paper, that most of these workers had to take the easy way out of the basic classificatory difficulties that immediately faced them.

A worker in the Museum is particularly fortunate in the facilities available there for research involving an examination of the literature and the writer's position as officer-in-charge of one of the
Museum's evacuation centres made it opportune in respect of both time and other facilities, to carry out this work which, it is his sincere hope, will save future workers, even if only in respect of the catalogue of species, much time and labour preliminary to commencing the intensive study of some limited fauna of the Simul-iidae.

The writer has attached two supporting papers which he trusts will show that his acquaintance with the Simuliiidae is based on some knowledge of the creatures themselves and their mode of life as well as that which others have recorded in the literature.

An appendix listing some of the writer's other papers is added.

April 1946.

John Smart.
Assistant Keeper, 1st Class,
Department of Entomology,
British Museum (Natural History),
Contents.

I. PAPERS SUBMITTED AS A THESIS on "Studies on the Classification of the Simuliidae (Diptera)."


II. SUPPORTING PAPERS.


III. APPENDIX. Bibliography of other papers (excluding short notes, etc.).
THE
TRANSACTIONS
OF THE
ROYAL
ENTOMOLOGICAL SOCIETY
OF
LONDON


CONTENTS

PAGE

SMART, J., Ph.D. Simulidae (Dipt.) from
British Guiana and the Lesser Antilles . 1–11, 4 pl., 3 figs.

LONDON:
PUBLISHED BY THE SOCIETY AND
SOLD AT ITS ROOMS, 41, QUEEN’S GATE, S.W.7

Price 7s. 6d.
THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

Founded, 1833. Incorporated by Royal Charter, 1885.

PATRON—HIS MAJESTY THE KING.

OFFICERS and COUNCIL for the SESSION, 1940-1941.

K. G. BLAIR, D.Sc., President.
G. FOX-WILSON.
J. C. F. FRYER, O.B.E., M.A. Vice-Presidents.
N. D. RILEY.

N. D. RILEY, Treasurer.
O. W. RICHARDS, M.A., D.Sc., Secretary.

Other Members of Council.
E. A. COCKAYNE, M.A., M.D., F.R.C.P.
C. N. HAWKINS.
COL. F. A. LABOUCHERE.
Hugh MAIN, B.Sc.
SIR GUY A. K. MARSHALL, C.M.G., D.Sc., F.R.S.
A. M. MASSEY, D.Sc.

THE HON. MIRIAM ROTHSCILD.
J. SMART, B.Sc., Ph.D.
W. R. THOMPSON, Ph.D., D.Sc., F.R.S.
B. P. UVAROV, D.Sc.
A. WELTL.
V. B. WIGGLESWORTH, M.A., B.Ch., M.D., F.R.S.

Finance and House Committee.
A. WELTL (Chairman).
BRIG.-GEN. B. H. COOKE, C.M.G., C.B.E., D.S.O.
C. N. HAWKINS.
FRANCIS HEMMING, C.M.G., C.B.E.
R. W. LLOYD.
J. SMART, B.Sc., Ph.D.

Publication Committee.
V. B. WIGGLESWORTH, M.A., B.Ch., M.D., F.R.S. (Chairman).
E. A. COCKAYNE, M.A., M.D., F.R.C.P.
G. FOX-WILSON.
A. M. MASSEY, D.Sc.

HUGH SCOTT, M.A., Sc.D.
W. R. THOMPSON, Ph.D., D.Sc., F.R.S.

Library Committee.
B. P. UVAROV, D.Sc. (Chairman).
E. B. BRITTON.
B. M. HOBBY, M.A., D.Phil.
R. W. LLOYD.

W. H. TAMS.
W. R. THOMPSON, Ph.D., D.Sc., F.R.S.

Committee for the Protection of British Insects.
W. G. SHELDON (Chairman).
CAPT. E. BAGWELL-PURFOY.
C. L. COLLENETTE.
W. J. DOW.
J. C. F. FRYER, O.B.E., M.A.

COL. F. A. LABOUCHERE.
N. D. RILEY.
H. M. EDELSMITH (Secretary).

The Executive Officers of the Society are ex-officio members of all Committees.

DELEGATES OF THE SOCIETY TO:
1. British National Committee for Biology (Royal Society).
   Dr. Karl Jordan, B.Sc., F.R.S., appointed 1936.
2. Conference of Delegates of Corresponding Societies of the British Association for the Advancement of Science.
   Mr. H. B. Coll, M.A., appointed 1939.
   J. C. F. Fryer, O.B.E., M.A. Francis Hemming, C.M.G., C.B.E.
   A. D. Innes, M.A., Sc.D., F.R.S.
4. Local Committee of Management of Wicken Fen.
   Mr. H. M. Edelstern. Mr. E. C. Behcull.
   [Delegates nominated by Committee for the Protection of British Insects.]
5. National Trust for Places of Historic Interest or Natural Beauty.
   Mr. W. G. Sheldon, appointed 1922.
   Mr. W. Fennes, appointed 1934.
   Dr. C. B. Williams, appointed 1937.
SIMULIIDAE (DIPT.) FROM BRITISH GUIANA AND THE LESSER ANTILLES

By John Smart, Ph.D.

(Department of Entomology, British Museum (Natural History).)

WITH PLATES 1 TO 4 AND THREE FIGS. IN THE TEXT.

(Manuscript received 5.vii.1939.)

(Read 7th February, 1940.)

Pinto (1932) in his review of the Simuliidae of South and Central America states that two species have been recorded from British Guiana, one from St. Vincent and two from Trinidad. In the course of an expedition to British Guiana, Trinidad and some of the Lesser Antilles made, in the summer of 1937, by Dr. O. W. Richards and his party of which I was a member, specimens of Simuliidae were collected in British Guiana, Trinidad and Tobago. In working these out and in examining the collection in the British Museum it has been found that the species found or recorded in British Guiana and the Lesser Antilles are seven from British Guiana, three from Trinidad, one from Tobago, one from Montserrat and one from St. Vincent.

Unfortunately Pinto (1932) in his review of the family, gave no keys to the species. Lutz (1910) gave a key to the species recorded by him in Brazil, but this key is almost useless for the fauna of the Guianas and the neighbouring parts because it does not include any of the species from Central America and the Antilles whence several species have been described since the publication of Lutz’s paper.

Lutz (1928) recorded eight species of Simuliidae from Venezuela, and Pinto (1932) increased this number to ten, but neither author gave a key. Surcouf and Rincones (1911) in their paper on Venezuelan Diptera mention twenty-nine species, but it seems that they were dealing with species that they thought might be found in the region rather than with those known to occur. Knab (1914) published a paper on the Simuliidae of Peru, and Edwards (1931) published on the Simuliidae of Patagonia and South Chile, both of which regions are probably faunistically remote from the Guianas and the Antilles.

Most of the other writings on the Simuliidae of the regions under discussion consist of isolated notes and descriptions of species.
In working out the material collected by Richards and myself cognisance was taken of all the species actually recorded from the Guianas, Venezuela and the Lesser Antilles. Certain other species from Central America were considered as were some of the Brazilian and other South American species. In general, however, species, originally described from outside the area, that have not been recorded as occurring within it, have been omitted since their inclusion would have eventually involved the consideration of the whole Central and South American fauna, a task which must be deferred.

In the key to the females, which is presented below, all the species recorded in the area have been included, with a few additional ones that it seemed might perhaps be found at a later date. Wherever possible the key has been made using characters given by the original authors in their descriptions of the species. The key aims at being a practical one and does not attempt to express the phylogenetic relationships of the species.

Those who may wish to go further into the distribution, classification, etc. of the Simulidæ of Central and South America should commence with the papers of Pinto (1932), Edwards (1931) and Orfila (1939) and work backwards from these. Attention should be paid to Malloch (1911) and Dyar and Shannon (1927) on the general classification of American Simulidæ. Other references, apart from those mentioned in the notes on the species, will be found at the end of this paper. Bequaert (1934) has given an extensive bibliography.

The Simulidæ are of economic importance. When present in large numbers their bites can cause so much pain and irritation that both man and animals may have to cease work. They are also the proved transmitters of parasitic nematode worms of the genus Onchocerca in both the Old and New World. Recently both Donovan (1939) and Giglioli (1939) have pointed out that the problem of controlling Simulium must be considered in relation to any large-scale settlement of the hinterland of British Guiana.

I am indebted to Professor P. A. Buxton of the London School of Hygiene and Tropical Medicine, to Professor R. M. Gordon of the Liverpool School of Tropical Medicine and to Mr. B. Jobling of the Wellcome Research Institution for kindly lending me, for examination, material of various species of S. American Simulium deposited in the collections at their laboratories.

Key to Simulium (females only).

1. Dorsum of thorax yellow, with or without narrow silver stripes
   - Dorsum of thorax otherwise
   2.
   3. Dorsum of thorax with longitudinal silvery or white stripes
   - Dorsum of thorax without such stripes
   4.
   5. 2 such silvery stripes on thorax
   - 4 such stripes
   6.
   7. Femora and tibia darkened distally
   - Femora yellow, tibia of first and second legs infuscated, tibia of third leg dark brown
   8.
   9. Sides of thorax and abdomen yellow with a certain degree of infuscation
   - Sides of thorax and abdomen brownish showing only traces of a yellow tinge
   10.

1 It should be noted that Pinto in preparing his paper, published in 1932, apparently was not able to include the species described by Edwards in his paper published in 1931. Pinto's long and valuable paper presumably had to go to press before Edwards' paper became available.
6. Hind femora pale  
   - Hind femora dark  
   7. Thorax showing a marked pattern on the dorsum. The pattern due to brightly iridescent areas of a varying extent on a dark ground-colour. The insect has to be moved in the light fully to appreciate the pattern and should be viewed beneath the binocular microscope with its head away from the observer and with the light coming on to the specimen from in front, or slightly to one side, of the microscope.
   8. Thorax plain, all one ground-colour. A pearly pollen may be present on the dorsum which may even give a shifting iridescence when the incidence of the light is altered. There is, however, no distinctive pattern beyond certain indistinct longitudinal dark stripes caused by interruption of the pollensate. Small bright metallic hairs may be present.
   9. Thorax showing a marked pattern on the dorsum. The pattern due to brightly iridescent areas of a varying extent on a dark ground-colour. The insect has to be moved in the light fully to appreciate the pattern and should be viewed beneath the binocular microscope with its head away from the observer and with the light coming on to the specimen from in front, or slightly to one side, of the microscope.
   10. Iridescence on some of the abdominal segments in addition to the first visible one.
   11. Only the first visible segment with iridescence.
   12. Iridescence in the form of two green-gold bands on the dorsum of the thorax.
   13. The silvery iridescence on the dorsum of the thorax in the form of two large “commas” with heads towards the front.
   14. Each silvery stripe, anteriorly, narrower than the median dark area between it and the stripe on the other side. Bases of the anterior abdominal segments opaque velvet black.
   15. Each silvery stripe, anteriorly, as broad or broader than the median dark area between it and the stripe on the other side. The opaque areas on the anterior abdominal segments are constricted and formed into spot-like patches.
   16. Legs entirely yellow except for a slight darkening of the tarsi of the forelegs.
   17. 2nd and 3rd pairs of legs all dark in colour with only a slight trace of light colour on the bases of the tarsi.
   18. Complete absence of any marks or pattern on the dorsum of the thorax, which is, however, covered with fairly widely spaced-out short scale-like golden hairs.
4 Dr. John Smart on Simulidiæ (Dipt.) from

—. Thorax as in lugucre but shiny and with normal hairs not scale-like and
golden                                                                                      metallicum Bellardi, p. 7.
19. Legs dark brown (black) and white                                             placidum Knab, p. 7.
—. Legs dark brown and yellow                                                                                     20.
—. Thorax dull black with short golden scale-like hairs over its surface                 guianense Wise, p. 4.

Simulium amazonicum Goeldi.

1905, Os mosquitos no Para : 138.

This species is recorded from Brazil, Paraguay, Peru, British Guiana and
Venezuela. It is represented in the British Museum collection by specimens
from British Guiana and the Amazons.

Lutz (1917) figured the adult and Lutz (1928) the adult, the pupa and the
larva.

The type is, presumably, in the Goeldi collection in Berne.

Simulium antillarum Jennings.


The localities from which the type series was collected were St. Croix
(D.W.I.) and Jamaica (B.W.I.). It is represented in the British Museum
collection by specimens from Jamaica and Montserrat (Woodlands, sucking
human blood, 20.ix.1938). Jennings described both the male and the female,
and his types are, presumably, in the U.S. National Museum, Washington.
He stated that it was reared from pupae but does not describe them.

Simulium dinellii Joan.


The original description is fairly detailed and the insect is figured. It has
been recorded from the Argentine and Peru. The British Museum collection
contains specimens from Argentina (Jujuy, xi.1938) and Bolivia (Villa Montes).

The type locality is in the Argentina and the type may have been de­
posited in the Museum at Buenos Aires.

Simulium exiguum Roubaud.


This species has been recorded from Guatemala and Venezuela, the latter
being the type locality. There is one specimen which is probably a paratype
in the British Museum collection, determined by Roubaud, from the type locality.
The type is presumably in the Paris Museum.

Simulium guianense Wise.

1911, Timehri (3) 1 : 252.

Wise states that this species is known to the natives in British Guiana as
the "Itanemi fly" and is distinguished by them from the "Pium," which Wise
identified as S. amazonicum Goeldi. The specimens from which the original
description was made were taken on the Essequibo River and its higher branches
including, if the labels on Wise's specimens in the British Museum, which are
not Wise's original labels, are correct, the Rupununi River.

Although he does not state so in his account of S. guianense, Wise apparently
sent specimens of this species to the British Museum and the Liverpool School
of Tropical Medicine. All the material from these two institutions has been
examined in the course of the preparation of this paper and the conclusion
reached that the single specimen at the Liverpool School, and the four specimens in the British Museum, are to be regarded as cotypes. One of the last four is now hereby selected as the lectotype and has been labelled as such, and in consequence the other specimens now rank as paratypes. Wise in his description of the species is somewhat misleading when he describes his flies as "of a light silvery gray colour." This impression is due to the fact that the dorsum of the thorax is covered with short scale-like golden hairs which can, however, only be appreciated as such when the specimens are examined under the binocular microscope. Apart from this, Wise's description, especially of the legs, enables the insect to be identified.

Specimens of *S. guianense* were taken by me when apparently about to bite, on the Kaieteur savannah and at the portages at Amatuk and Warratuk falls on the Potaro River during the first week of September 1937.

Imagines were also obtained from pupae taken on the leaves of species of Podostemaceae collected in the water in the Amatuk and Warratuk falls and in the water at the lip of the Kaieteur Fall itself. These plants grow on the bare rock in places that are completely dry during the dry season and completely submerged during the wet season. They only grow in places where the current is rapid to torrential. In some places the growth of the plants is almost moss-like, while in other places frond-like leaves that trail in the water, and are over six feet in length, are produced. When the water recedes in the dry season the leaves rot away very rapidly and the stumps of the plants, now dry and exposed on the rocks, burst into flower. The pupae and the larvae of *S. guianense* were found on the submerged leaves of these plants in places where the water was flowing with considerable force. They were found at depths varying from a few inches to a foot and a half; the force of the water prevented leaves being collected from greater depths. The pupa and its cocoon are shown in fig. 1.
and the male genitalia in fig. 2. Since Wise described the female only, the
specimen of which the genitalia are here figured may be regarded as the allotype.

*Simulium haematopotum* Malloch.


Malloch records this species from Mexico and Cuba. It has also been re­
corded from Guatemala and Porto Rico. The British Museum collection has
specimens from Mexico and Apoteri, Essiquibo (ix.–x.1926), with a note to the
effect that they are called “Cabourna flies.”

I collected specimens of this species at Warratuk and Tukoit on the Potaro
River (31.viii.1937), where it was biting members of the party, and when biting
and by sweeping, on the savannah at the Kaieteur Fall (4–6.ix.1937). It was

**Fig. 2.—*S. guianense*, male genitalia.**

also bred from pupae found on the leaves of an aroid (*Dieffenbachia paludicola*
N. E. Br. ex Gleason) in a forest creek in high forest near Mazaruni Settlement
on the Essiquibo in September. Eggs were also found on these leaves.

The type is in the United States National Museum, Washington.

*Simulium incrustatum* Lutz.


São Paulo, Brazil, is the type locality. It has also been recorded from
Venezuela. The pupa has been figured by Pinto (1931) and the type is
presumably in the Instituto Oswaldo Cruz. There are no specimens in the
British Museum collection.

*Simulium limbatum* Knab.


The original series of this species was collected on the Rupununi River by
Dr. K. S. Wise in ix.1913. They were apparently taken along with specimens
British Guiana and the Lesser Antilles.

of *S. amazonicum*. The type is now in the British Museum and there are three paratypes in the collection of the Wellcome Bureau of Scientific Research, London.

*Simulium bugubre* Lutz.


This species has only been recorded from Venezuela, Maracay, which is the type locality. Lutz gives figures of both the female and the pupal respiratory filaments. The British Museum collection does not contain any specimens.

The type material is presumably in the Instituto Oswaldo Cruz.

*Simulium lutzianus* Pinto.


This species from Venezuela was described by Pinto from the pupae alone. Pupae closely resembling those figured by Pinto (1932) were taken by me from a small stream in low bush, that had recovered from burning, on the savannah at the Kaieteur Fall in British Guiana, 6.ix.1937. The imagines had emerged; the pupae were attached to the grass-like leaves of a species of Cyperaceae trailing in the water.

*Simulium metallicum* Bellardi.


This species has been recorded from Mexico, Costa Rica, Guatemala and Trinidad. The type locality is Mexico; the type may be in the Museum at Florence. The British Museum collection contains specimens from Mexico, Costa Rica and Trinidad (Port of Spain, ii.1912, and Mt. Harris, vii.1924). Also from Trinidad (Aripo, 28.ix.30) in London School of Hygiene and Tropical Medicine collection.

*Simulium ochraceum* Walker.


Originally described from Mexico, this species has since been recorded from Venezuela by Lutz (1928). The British Museum collection contains a series of specimens from Mexico but the type is lost. Also from Jamaica in London School of Hygiene and Tropical Medicine collection. There is some confusion in the literature as to the identity of this species.

*Simulium paraguayense* Schrottky.


The type locality of this species is Paraguay but it has also been recorded from Argentina, Brazil and Venezuela. The type is lost. The species is not represented in the collection of the British Museum.

*Simulium perflavum* Roubaud.


Roubaud described this species from specimens collected by Dr. Lutz in São Paulo, Brazil. The British Museum collection contains a male labelled type and a second male labelled paratype.

*Simulium placidum* Knab.


The only record of the occurrence of this species is that in Knab’s description of the type, which with other specimens came from Trinidad, taken at the Arima
River on 31.xii.1913 by the late F. W. Urioh. The British Museum collection includes the type and a series collected by me in Trinidad on the Naranja-Tucuchi Trail 30.x.1937 and on the Blanchisseuse Road at its junction with the upper end of the Verdant Vale Road, 31.x.1937, and in Tobago, Pigeon Peak at 1000 ft. 16.x.1957, and in the Forest Reserve on the Green Hill to Castara Rd. above 1000 ft. 18.x.1937.

The type is now in the British Museum. There are 2 paratypes in the collection of the Wellcome Bureau of Scientific Research.

*Simulium quadrivittatum* Loew.


This species is recorded from Costa Rica, Porto Rico, Panama and Cuba, the last being the type locality. The British Museum collection contains material from Costa Rica (Orosi, i.1938), Jamaica and Panama Canal Zone. Also from Jamaica and Costa Rica (Sigurres, l.xii.1938 and Orisa, l.vi.1938) in the London School of Hygiene and Tropical Medicine collection.

The type, if extant, may be in the Zoological Museum, Berlin.

*Simulium rubrithorax* Lutz.


Serra da Bocaina and Batataes, Brazil, are the type localities of this species which has, however, also been recorded by Lutz (1928) from Venezuela. Lutz (1928) has figured the adult, the pupal respiratory organs and cocoon; Pinto (1932) has illustrated the cocoon.

A series of females and one male were taken by me attracted to light at the rest house at the Kaieteur Fall on the Potaro River on 6.ix.1937, on a dark night. A series of pupae was taken in a stream in the high forest on the trail from Tukeit to the top of the Kaieteur Fall at a point about 2 miles from the rest house. They were all, along with some larvae, on the sandstone bed of the stream. This stream must have been a veritable torrent in the rainy season but at the time of collecting the water was flowing over the sloping sandstone bed in a steady sheet without much force and in most places an inch to six inches deep. Attempts to rear these pupae failed but dissection of some of the more fully developed specimens revealed that the imagines belonged to a species with a yellow thorax and that, in certain other details which it was possible to check, they corresponded with the adult specimens of *S. rubrithorax* taken at the rest house. The cocoons corresponded exactly with the figures of Lutz and Pinto but the pupal respiratory organs have from 14 to 22 filaments (fig. 3). Lutz shows only 8 filaments in his figure, it may be noted, however, that the large number of filaments is due to branching of 7-11 main stems of the whole respiratory organ.

Apart from the series mentioned above there are no other specimens in the British Museum collection. The type is presumably in the Instituto Oswaldo Cruz.

*Simulium samboni* Jennings.


This species was reared from pupae taken in the Panama Canal Zone. There are no other records of its capture. The pupae were not described, and the type series, which contains both males and females, is in the United States National Museum, Washington. It is unrepresented in the British Museum collection.
British Guiana and the Lesser Antilles.

_Simulium sanguineum_ Knab.


The only record of this species is from Colombia, where the type series was taken “biting man.” The type is now in the British Museum. There is a paratype in the collection of the Wellcome Bureau of Scientific Research, London. The London School of Hygiene and Tropical Medicine collection has specimens from British Guiana. The British Museum collection contains specimens from British Guiana (R. Essesquibo–Rupununi, Apotari, 9.x.1926; Thanami Creek, 400 miles from Coast, 1908). The collector noted that it was biting in the last locality and was known by the native name of “Itan.” Finally there are specimens from Panama (Darien Province, 29.i.1933 and Chucunaque R., 7.ii.1933).

![Simulium sanguineum](image)

3

_Fig. 3._—_S. rubridorsus_, pupa.

_Simulium subnigrum_ Lutz.


The type locality for this species is Brazil but it has also been taken in Venezuela. Pinto (1932) has figured the pupal respiratory organ. The British Museum collection contains a series of specimens taken by me in Trinidad at the summit of the Blanchisseuse Road, 31.x.1937.

The type is, presumably, in the Instituto Oswaldo Cruz.

_Simulium tarsale_ Williston.


Williston described this species from 3 females taken in St. Vincent. The material described in the paper in which the species was described came to the British Museum but no trace can be found of the types of this species of _Simulium_; nor does the collection contain any other specimens. One or
more of them may, perhaps, be in some part of Williston's collections in the United States of America.

**Simulium versicolor** Lutz.


Lutz figured both the adult female and the pupal respiratory organs in his description of this species which comes from Venezuela, and has not, so far, been recorded from any other place. It is unrepresented in the British Museum collection.

The type is, presumably, in the Instituto Oswaldo Cruz.

**Bibliography.**

The following is a list of the more comprehensive papers dealing with Central and South American Simuliidae. It does not include all papers in which there are references to, or descriptions of, Simuliidae, but by using these papers as sources it should be possible to trace down all the literature.


—, 1910, Segunda contribuição para o conhecimento das espécies brasileiras do gênero "Simulium." *Mem. Inst. Oswaldo Cruz,* 2: 213–267. (The above two papers of Lutz are in Portuguese and German.)


J. Smart. Simuliidae from British Guiana.
J. Smart. Simuliidae from British Guiana.
J. Smart. Simuliidae from British Guiana.
Fig. 1. Habitat of *Simulium guianense* Wise. The top of the Kaieteur Fall on the Potaro River, British Guiana. The river is about 300 feet across at this point and the fall some 740 feet in height.

2. Habitat of *Simulium guianense* Wise. Podostemaceae growing on the rocks at the lip of the Kaieteur Fall.

Plate 2.

Fig. 3. Habitat of *Simulium guianense* Wise. Amatuk Fall (Rapid) on the Potaro River, British Guiana.

4. Habitat of *Simulium guianense* Wise. Podostemaceae growing on the rocks in the Potaro River at Amatuk Fall.

Plate 3.

Fig. 5. Habitat of *Simulium guianense* Wise. Warratuk Fall (Rapid) on the Potaro River, British Guiana.

6. Habitat of *Simulium lutzianus* Pinto. Small stream in bush that had recovered from burning on the Savannah at Kaieteur Fall, British Guiana.

Plate 4.

Fig. 7. Habitat of *Simulium rubritorax* Lutz. The sandstone bed of stream in high forest near Tupeit on the Potaro River, British Guiana. The water level was very low at the time when the specimens were collected.

PUBLICATIONS

The Publications of the Royal Entomological Society are Transactions and Proceedings.

The Transactions form an annual volume, each paper in the volume being issued as a separate part. The parts are issued irregularly throughout the year.

The Proceedings are issued in three series:

Series A. General Entomology
Series B. Taxonomy
Series C. Journal of Meetings

Series A and B are issued in twelve parts, forming an annual volume of approximately 240 pages.

The following information is supplied for the guidance of authors wishing to submit papers for publication in any of the Society's journals.

INTRODUCTORY

The Society is prepared to undertake the provision of a reasonable number of text figures. The original drawings for such figures must be supplied by authors. Such drawings or groups of drawings must be drawn to a scale which will permit of their reduction to an area of dimensions not exceeding $7\frac{1}{4} \times 4\frac{3}{4}"$. In the case of the Proceedings Series A and Series B, authors are required to pay for the necessary blocks for the provision of plates, half-tone and coloured work.

A uniform method is adopted for the citation of bibliographical references in the Society's publications as follows:


Titles of periodicals cited are to be abbreviated in the manner indicated in the World List of Scientific Periodicals, 2nd edition, 1934.

Authors are entitled to receive 25 copies of their papers free of charge and may purchase additional copies provided that request be made before publication.

Papers offered for publication should be sent to the Secretary, Royal Entomological Society of London, at 41, Queen's Gate, London, S.W.7, and must be typewritten on one side of the paper only. Sufficient space must also be left between the lines for editorial corrections.

The copyright of the Society's publications is vested in the Society.

TRANSACTIONS

Papers offered for publication in the Transactions are considered by the Publication Committee of the Society, which meets usually in the months of May and November. In order that papers may be considered at these meetings it is necessary for the manuscript and drawings for any illustrations to be in the hands of the Secretary fourteen days before the meeting of the Committee.

Papers of less than eight printed pages (approximately 7000 words) will not normally be accepted for the Transactions, and papers by authors who are not Fellows of the Society must be communicated by a Fellow.

PROCEEDINGS SERIES A AND SERIES B

Papers submitted for publication in either Series A or Series B of the Proceedings by authors who are not Fellows of the Society may be accepted if they are communicated by a Fellow. Preference will be given to papers written in the English language, and papers of more than eight printed pages (7000 words) will not normally be accepted for publication in these journals.

PROCEEDINGS SERIES C

Series C is issued prior to every General Meeting. It contains abstracts of exhibits to be shown and communications to be made, together with the titles of papers accepted for publication.

The annual subscription to Series A. General Entomology is £1 4s. od.; Series B. Taxonomy, £1 4s. od. (single parts 3s. od.); and Series C. Journal of Meetings, 6s. od.

As from January 1936 the journal Stylus is continued as Proceedings Series B. Taxonomy. Copies of volumes 1-4 are available at £1 16s. od. each, post free.
MEETINGS
TO BE HELD IN THE SOCIETY'S ROOMS
41, Queen's Gate, S.W.7

1940.

Wednesday, October 2 5.0 p.m.
" November 6 5.0 p.m.
" December 4 5.0 p.m.

1941.

Wednesday, January 15 (Annual Meeting)
" February 5 5.0 p.m.

THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

The Fellowship and Fees

Fellows pay an Admission Fee of £3 3s. The Annual Contribution of £2 2s. is due on the first day of January in each year, and is payable in advance. Fellows under the age of 25 years may pay the entrance fee in three equal annual instalments.

Fees should be paid to the Treasurer, at 41, Queen's Gate, S.W.7, and not to the Secretary.

Fellows desiring to pay their Annual Contribution through their bankers may obtain an official form of banker's order by applying to the Treasurer.

Fellows whose Contributions for the current year have been paid are entitled to receive the Transactions and Proceedings of the Society free of charge. Further copies may be purchased at reduced prices by applying to the Registrar.

Forms of application for Fellowship, copies of the Bye-Laws and the List of Fellows may be obtained from the Registrar.

Meetings and Exhibitions

Fellows and others wishing to make a communication to a General Meeting of the Society are requested to send in their names, the title of their exhibit, and a short abstract of their remarks, to the Registrar fourteen days before the meeting at which it is proposed to make the communication. Should it be desirable to publish a fuller account of the communication the manuscript may be submitted for publication in Proceedings Series A or Series B. If the epidiascope is required, 24 hours' notice must be given. Objects for projection should not exceed 6 ins. by 6 ins.

Fellows resident abroad, or otherwise unable to attend meetings, are reminded that notes or observations sent to the Secretary may be communicated to a General Meeting on their behalf.
NOTES ON SIMULIIDAE (DIPTERA)

By John Smart, Ph.D., F.R.E.S.

(Department of Entomology, British Museum (Natural History)).

The notes which follow are in the nature of a postscript to my paper on SIMULIIDAE from British Guiana and the Lesser Antilles (Smart, 1940).

*Simulium amazonicum* Goeldi.

Goeldi stated in his original description that he had deposited a series of co-types in the British Museum. I did not have these before me when preparing the paper mentioned above. During the evacuation of the Diptera collections in 1941, on account of air raids, the tube containing Goeldi's co-types was found. The material is in spirit and, except for expected fading, in good condition. Since the material is in spirit a full redescriptions of the species cannot be prepared, but I give below some notes on certain characters that can be seen in the spirit material and which have some bearing on the subgeneric position of the species and its identification. All the specimens are females.

*Fig. 1.*—Female genitalia of *Simulium amazonicum* Goeldi and *Simulium guianense* Wise. A. *S. guianense*, tip of anal lobe and cercus; B. *S. guianense*, genital fork; C. *S. amazonicum*, genital fork; D. *S. amazonicum*, tip of anal lobe and cercus.

The thoracic pattern, as far as it can be seen in spirit material, corresponds almost exactly with the pattern figured by Porto (1939). The coloration of the hind leg is as figured by Lutz (1917). The pedisules and the calcipala are both present and the claws are simple (without a basal tooth). The wing is without a basal cell, the radius is not
forked and its basal sector is bare of hairs. The antennae have eleven segments. The tergites of the apical segments of the abdomen are shiny. The pleural tuft is present but there are no hairs on the membranous area of the pleuron. The female genitalia are now illustrated (fig. 1).

The re-examination of Goeldi's co-types, as far as it has been possible to carry it out, raises no doubts as to the correct recognition of this species by various workers. A slight emendation of my key (Smart, 1940) to the effect that the median dark stripe may reach the anterior margin of the dorsum of the thorax is called for, but this does not affect the use of the key for practical determinations.

The above descriptive notes are based on a series of 38 females in spirit accompanied by the following label in the handwriting of the late E. E. Austen: "Simulium amazonicum, Goeldi.—Co-Types, (The 'Pium'), Born Lugar, Rio Purus, Amazons Region, Brazil. May, 1904.—Dr. J. Huber. Pres. by Dr. E. A. Goeldi. (Reed. 6-vi-1905)", and a small label in an unknown hand, reading "Pium, Born Lugar, (Purus), v.1904." The material was unregistered and now has the registration no. B.M. 1941 : 19. Two of the specimens have been pinned and dried and two have been dissected and mounted in balsam on microscope slides. Since it is not clear whether Goeldi (loc. cit.) was using the term "co-type" strictly or loosely, in the sense common with continental workers, as an equivalent of para-type, I refrain from selecting a lecto-holo-type. I have, however, marked the slide from which the present figure of the female genitalia was made. This plesio-co-type may be designated as the lecto-holo-type should it be considered that Goeldi was using the term "co-type" in its correct sense.

Simulium clavipes Malloch.


I carelessly overlooked this species from Guadeloupe when preparing the paper (Smart, 1940) referred to above. Pinto (1932), in his catalogue of the Simulidae of Central and South America, also omitted it. The type series, which were all females, came from "Guadeloupe, West Indies, 4,000-foot level, July (August Busch)", and are presumably in the U.S. National Museum at Washington. It is not clear from Malloch's text whether the type series consists of one or more specimens.

I consider it to be a synonym of Simulium tarsale Williston which I deal with below.

Simulium guianense Wise.

1911, Timchri (3) 1 : 252.

The rarity of the work in which this species was originally described has led to its being ignored by many workers. I should have mentioned in my paper on the Simulidae from British Guiana and the Lesser Antilles (Smart, 1940) that the original description was republished in 1912, J. trop. Med. Hyyg. 15 : 43, where it may be more accessible to some authors. In view of the fact that Fairchild (1940) has published figures of the female genitalia of several species of Simulidae from Panama I give, herewith, a figure of the female genitalia (fig. 1) of S. guianense made from a specimen (plesio-homo-topo-type),
taken by myself in British Guiana, Sept. 1937, which had been compared with the type series before dissection and determined as conspecific. I suspect that *S. lugubre* Lutz (see below) may prove to be a synonym of *guianense* but cannot come to a conclusion on this point without having authenticated specimens of Lutz's species before me.

**Simulium lugubre** Lutz.


Fairchild (1940) considers this species a synonym of *Simulium mexicanum* Bellardi. Although Lutz's textual description gives characters that enable *lugubre* to be separated from *guianense* Wise (Smart, 1940), the colored figure of the former published by Lutz bears a remarkable resemblance to the latter species. There is also a general resemblance in the pupal filaments (vide Lutz's figure, *loc. cit.*) of the former species and my figure (Smart, 1940) of the filaments of the latter species, though the former are figured as longer than the latter.

**Simulium ochraceum** Walker.


Although this paper is mainly concerned with material supposed to be lodged in the British Museum, reported as missing and recently recovered, I regret that the type series of this species remains unknown to me.

**Simulium quadrivittatum** Loew.


I have a letter (dated 30.vii.1940) from Mr. C. T. Parsons which reads as follows: "I notice in your recent paper that you state that the type of *Simulium quadrivittatum* Loew is possibly in Berlin. Like all of Loew's New World types, the type of *quadrivittatum* is in the Mus. Comp. Zoology. There are two types on one pin, labelled 'Cuba, Gundlach'." I have to record my thanks to Mr. Parsons for this information.

**Simulium tarsale** Williston.


In my paper, cited above, I stated that the type series of this species, which should have been in the British Museum, was not to be found there. During the evacuation of the Diptera collections on account of air raids in 1941 the three specimens which constitute the type series were discovered. These three specimens ranked as co-types and the labels on them leave no doubt as to their authenticity. It would appear that these specimens, as well as a few other Nematocera from the same collection, were not put into the cabinets at the time when the bulk of the collection from St. Vincent was incorporated into the general collection of Diptera.
Dr. John Smart's notes on Simuliidae.

Williston in his description stated that there were three specimens. He described only the female. The legend for the plate on which appear the figures of the wing and fore leg of *S. tarsale* reads “fig. 25. *Simulium tarsale*, wing 25a $^3$ front tarsus.” The three specimens before me now are undoubtedly all females and it would appear that the above legend, which is repeated in the figure citation in the text, is erroneous. The figure of the tarsus depicts all the characters exhibited by the tarsi of the females of the type series.

Although referred to by both Malloch (*loc. cit.*) and myself (*loc. cit.*) specimens of *tarsale* have not been recognised since it was originally described.

I have compared the type specimens of *tarsale* character for character with Malloch's description of *claripes* (*loc. cit.*) and have no hesitation in sinking the latter name as a synonym of the former. Such differences as can be found between the descriptions of the two species as they were published are of such a kind as may be said to be entirely due to differences in the subjective conceptions of the two authors. The type series of *tarsale* all have the vestiture of upright brown hairs that Malloch described for *claripes* and which he assumed *tarsale* lacked since Williston did not mention it; the abdomens of the type series of *tarsale* are all very shrunken, which accounts for the small size, “2 mm.” stated by Williston.

The following characters are possessed by the type specimens though not mentioned by Williston. Antennae with 11 segments and a marked constriction between segments 2 and 3. Face and frons both matt. The brassy reflecting hairs that lie adpressed to the dorsum of the thorax are quite definitely hair like and are not completely reduced to the scale-like metallic structures found on some species. The wings have no basal cell, the radius is unforked and has the basal sector bare, and the cubitus is strongly bent. The coloration of the legs varies slightly from specimen to specimen. It would appear that in species of *Simulium* where the leg coloration does not consist of definite bands it is dangerous to rely overmuch on this character. In one co-type of *tarsale* the second tarsal segment of the hind leg would be described as “dark brown with the basal half pale,” in another it is entirely dark brown. There is also a variation in the depth of the general pigmentation. Thus in one specimen the dorsal surface of the humeral region is paler than is the same region in the other two co-types. This lightening of the pigmentation is general and affects all the other pigmented parts. The pedisulci and calcipala are present. The genitalia are not visible and I have preferred not to dissect them out at the present time. The species runs to the subgenus *Simulium* in Edwards's (1931) key; the examination of the co-types calls for no modification of my key (*Smart, 1940*); Malloch (*loc. cit.*) did not place *tarsale* in his key and the species will therefore run out to its synonym *claripes*.

One of the co-types lacks a wing and is therefore presumably the one that was figured. I designate this specimen as the lecto-holo-type. The remaining two specimens therefore now rank as paratypes. All three are labelled as follows: “Windward side St. Vincent, W.I., H. H. Smith, West Indies, 1907-66” (1907-66 is the British Museum registration no.); the lecto-holo-type and one paratype are labelled “1,000 feet” and the lecto-holo-type carries a ms. label “Forest, by stream, March” and Williston's determination label. I presume, however, that the data on the lecto-holo-type apply to all three specimens.
Dr. John Smart’s notes on Simuliidae.

References.

Since the publication of my paper on Simuliidae from British Guiana and the Lesser Antilles four recent papers dealing with Neotropical Simuliidae have come to my notice; they are marked * in the list of references given below.


NOTES ON SIMULIIDAE (DIPTERA). II

By John Smart, B.Sc., Ph.D., F.R.E.S.

Department of Entomology, British Museum (Natural History).

Edwards (1931, 1934 and 1939) considered the family Simulidae to consist of but two genera: (i) Parasilimulium Malloch, 1914, with one species P. furcatum Malloch, 1914; and (ii) Simulium Latreille, 1802, to which he assigned all the other species. Enderlein (1921a, 1930, etc.) has proposed to recognise no fewer than 50 genera within the family. A few generic names within the family have been proposed at one time or another by some other workers.

The majority of the students of the family have found the Enderleinian system extremely difficult to work. Edwards (1931) sank all the then extant genera of Enderlein as synonyms of Simulium and the genera that Enderlein has erected since then have no greater claim to generic status than those sunk by Edwards. At the same time Edwards (1931) sank such genera as other workers had erected at that time as synonyms. Edwards (1931) divided his genus Simulium into seven subgenera, Prosimulium Roubaud, Cnophila Enderlein, Gigantolax Enderlein, Astrosimulium Tomoir, Ensulimulium Roubaud, Morop Enderlein and Simulium Latreille (restricted), but later (1934) he combined the last three into one subgenus, Simulium Latreille (restricted). Edwards (1939) did not discuss the generic classification of the Simulidae in detail, but he indicated his adherence to the system proposed in the papers cited above.

It thus comes about that, if the system of classification proposed by Edwards is followed, then, with the exception of Parasilimulium Malloch which is recognised as distinct by both Edwards and Enderlein, all the genera erected by Enderlein and others in the Simulidae must be regarded as synonyms of Simulium Latreille in the sense in which Edwards used the name.

The elimination of these genera as synonyms results in the appearance of a number of homonyms. Some of these have already been dealt with in published papers (e.g. Vargas (1943)); some, however, have not.

The purpose of the present paper is to deal with these homonyms in order that the species may be related to the generic classification of Edwards without confusion. The opportunity is taken of dealing with one or two other points of a similar nature. The fact that Edwards recognised subgenera does not of course affect the issue in respect of the homonyms. It may be noted that Enderlein is the author of many of the names applied to species that now require new names.

Simulium asakakae nom. n.

pro S. groenlandica (Enderlein) 1936 : 114 (Psilozia).

Both species come from Greenland. The first species, for which the new name is proposed, is the genotype of Psilozia Enderlein (1936).

Simulium orsovae nom. n.

pro S. latirostris (Enderlein) 1936 : 114 (Cryptectemnia).

A Romanian and a Peruvian species respectively. The first species, for which the new name is proposed, is the genotype of Cryptectemnia Enderlein (1936).

PROC. R. ENT. SOC. LOND. (B) 13. PTS. 11–12. (DECEMBER 1944.)
Simulium costaricensis nom. n.

pro S. rufidorsum (Enderlein) 1936 : 119 (Acropoma).
preoc. S. rufidorsum (Enderlein) 1936a : 289 (Pseudophlebotomus).

A Costa Rican and a Peruvian species respectively.

Simulium rövdeae nom. n.

pro S. arctica (Enderlein) 1936 : 119 (Schönaueria).
preoc. S. arctica Malloch 1914 : 37 (Simulium).

Enderlein's species is from Norway while Malloch's is from North America and Greenland.

Simulium wilhelmlandae nom. n.

pro S. piqgama (Enderlein) 1922 : 70 (Wilhelmia).
preoc. S. piqgama Zetterstedt 1838 : 802 (Simulium).

Enderlein's species is from Norway while Malloch's is from North America and Greenland.

Simulium wilhelmlandae nom. n.

pro S. mexicana (Enderlein) 1934b : 190 (Henicnetia).
preoc. S. mexicana Bellardi 1802 : 16 (Simulium).

Both species are Mexican. The first is the genotype of Henicnetia Enderlein (1934b).

Simulium tangae nom. n.

pro S. limbatum Enderlein 1921a : 200 and 1921d : 78 (Simulium).
preoc. S. limbatum Knab 1915 : 280 (Simulium).

Knab's species is from British Guiana; Enderlein's from East Africa.

Simulium sieuani nom. n.

pro S. limbatum (Enderlein) 1933 : 282 (Ectenippa).
preoc. S. limbatum Knab 1915 : 280 (Simulium).

Ectenippa limbatum was described from Peru.

Simulium canhalicum nom. n.

pro S. balcanicum (Enderlein) 1929 : 224 (Prosimulium).
preoc. S. balcanicum (Enderlein) 1924 : 285 (Wilhelmia).

Both are Bulgarian species.

Simulium lurleybayae nom. n.

pro S. augistifrons (Enderlein) 1934a : 292 (Trichodophagia).
preoc. S. augistifrons (Enderlein) 1921a : 200 and 1921b : 213 (Necrophagia).

The first species is from Peru, the second from France. Enderlein (1921b : 213) misspells the specific name as "augistifrons."

Simulium polae nom. n.

pro S. montana (Enderlein) 1921a : 200 and 1921b : 221 (Simulium).
preoc. S. montana Philippi 1865 : 633 (Simulium).

Philippi's species comes from Chile, Enderlein's from Germany. Enderlein (1930) transferred his species to Odognia.
Simulium pseudohirtipes nom. n.

pro S. nigripes (Enderlein) 1925 : 30 (Prosimulium).
syn. S. hirtipes Fries of Edwards (flyr. loc.)
proev. S. nigripes (Abreu) 1922 : 30 (Melosoma).
Not S. hirtipes Fries of Enderlein (flyr. loc.) (Prosimulium).

Enderlein (loc. cit.) maintains that the species which Edwards has in various
places identified as S. hirtipes Fries is not, in fact, that species but a different
one to which he, Enderlein, has applied the name nigripes. The new name is
required in case Enderlein's contention should, unexpectedly, prove correct.
According to Enderlein (1925 and 1922) S. hirtipes Fries of Enderlein has as a
synonym S. tomosvarji Enderlein (1921a : 200 and 1921b : 215). If Enderlein
is in error in his identification of S. hirtipes, then the name S. tomosvarji Ender-
lein is available.

Simulium maenieri nom. n.

pro S. affinis Meunier 1907 : 387.

The former is a fossil; the latter was published as a nomen nudum but, the
material seen by Stephens having been available to him, Edwards (1915) gave
the name as a synonym of S. variegatum Meigen.

Simulium baracorne nom. n.

pro S. rufocone (Barnes) 1926 : 191 (Odagmia).
proev. S. rufocone Macquart 1838a : 88 and 1838b : 84.

Barnov's species comes from Yugoslavia. Macquart's species is an Ethio-
pian one which does, however, extend to North Africa and Palestine. Synonyms
of S. rufocone Macquart are, according to authors, S. beckeri Roubaud, S.
divipes Pomeroy and S. annulipes Becker (not S. annulipes Shiraki; see
immediately below).

Simulium nacjapi nom. n.

pro S. japonicum (Shiraki) 1935 : 49 (Odagmia).

Both are Japanese species. S. annulipes Shiraki is, according to Kono and
Takahashi (1910), a synonym of S. japonicum Matsumura and thus no new name
is required for it (not S. annulipes Becker; see immediately above).

Simulium figueroa nom. n.

pro S. simile Silva Figueroa 1917 : 33.
proev. S. simile Malloch 1914 : 42c.
Not S. simile (Tonnoir) 1925 : 249 (Australosimulium).

Silva Figueroa's species is quoted by authors as "simile Silva" and "simile
Figueroa"; it is Chilean. Malloch's species is from North America and,
according to Dyar and Shannon (1927), is a synonym of S. arcticum Malloch,
1914.

Simulium austrosimile nom. n.

pro S. simile Silva Figueroa 1917 : 33.
proev. S. simile Malloch 1914 : 42c.
And S. simile Malloch 1914 : 42c.

Tonnoir's species is described from Tasmania.

Simulium jerichoensis nom. n.

pro S. flavipes Austen 1921 : 116.

Austen's flavipes comes from Palestine. The Stephens species is a nomen
nudum.
Hr. J. Smart's notes on Simuliidae (Diptera). II.

*Simulium irakae* nom. n.

pro *S. bipunctatum* Austen 1923 : 275.

Austen's species comes from Mesopotamia; he (*loc. cit.*) also described a variety of it from Palestine, which he named var. *buxtoni*. Knab (1913) sank *bipunctatum* Malloch (December 1912) as a synonym of *dinellii* Joan (April 1912).

*Simulium pertinax* Kollar 1832 : 19.

Not *S. distinctum* Malloch 1913 : 133.

Pinto's *latzianus* has priority but since the Enderleinian species sinks as a synonym no new name is required. Malloch's *distinctum* is dealt with immediately below. *S. pertinax* is a South American species; material from these regions identified as *rematum* Say is this species. The synonymy given above is after Lane and Porto (1939), who also give *S. inermabile* Schrottky and *S. flavifemur* (Enderlein) (*Chirostyla*) as synonyms.

*Simulium trivittatum* Malloch 1914 : 30.

Syn. *S. distinctum* Malloch 1913 : 133.

Dyar and Shannon (1927) erroneously stated that *distinctum* Malloch was described in Malloch's paper of 1914 and they appear to have made the species an inferior synonym of *trivittatum* Malloch simply because the description of the latter is above notes on the former on the same page. The facts are that, *distinctum* being preoccupied, *trivittatum* is the earliest available synonym by which the species can be called. Lutz's species is a synonym of *pertinax* Kollar (see immediately above).

*Simulium chilense* Philippi in Rondani 1863 : 90 and *S. chilense* Philippi 1865 : 631.

In a footnote in his catalogue Kertesz (1902 : 286) hinted that these two species might be synonymous; he also erroneously gave the date of the paper in which *S. chilense* was published as 1865 and attributed the species to Rondani.

Pinto (1932 : 728) gave the two species as distinct but, like Kertesz (*loc. cit.*), he erroneously gave the date of publication as 1865 and attributed the species to Rondani. The context in Pinto's paper indicates that he must have had his particulars of *S. chilense* from Philippi's original paper but his information about *S. chilense* from Kertesz's catalogue.

Reed (1888 : 8) lists *S. chilense* in his catalogue of Chilean Diptera but omits *S. chilium*. The introduction to his catalogue and the contents indicate that he was not aware of Rondani's paper (*loc. cit.*), in which some three dozen Chilean species of Diptera are dealt with, and many of those described as new are attributed by Rondani to Philippi.

Edwards (1931 : 139) treats *S. chilense*, but omits any mention of *S. chilium* either as a valid species or as a synonym.

*S. chilium* is the only species of *Simulium* noted in Rondani's paper; *S. chilense* is one of seven species noted in Philippi's paper.
Roudani's paper is not readily accessible and his brief diagnosis or description is quoted in full herewith:

"Gen. SIMULIUM Mg n.

"Sp. n. Chilleanum Phil.—Long. Mill. 3.

"Ater opacum, leviter grisei adspersum; pedibus, praecertim posticis, 
"puolo latreii sericeis—Alae limpidae.

"Chillean—Philippi."

Philippi's paper is more accessible and in addition Edwards (loc. cit.) has identified S. chilense and given notes on the species which he assigned to the subgenus Gigantodac Enderlein as defined by Edwards (loc. cit.). The original diagnosis may, however, be quoted with advantage since it immediately shows that S. chilense cannot be the same species as S. chilleanum.

"G. S. chilense Phil. oculis antennisque fuscig.; thorace laete rube.; abdomine nigro pedibus pallide testaceis. Long. corp. 1 1/4 lin., extens. alar. 4 1/2 lin.

"Marcus e prov. Vakdavia attuli."

This is followed by some notes on the species in the German language.

References.


—, 1931, Simuliidae. Dipt. Pot. S. Chile, 2 (Fase. 4) : 121-51.


—, 1921c (3rd June), Die systematische Gliederung der Simuliden. Zool. Anz. 53 : 43-46. (A reprint of the systematic part of Enderlein (1921a).)


Dr. J. Smart’s notes on Simuliidae (Diptera), II.


Lane, J., and Porto, E. E., 1839, Simulideos da região neotrópica, o género *Eusi-...


Philippi in Rondani, 1863.—See Rondani, 1863.


THE
TRANSACTIONS
OF THE
ROYAL
ENTOMOLOGICAL SOCIETY
OF
LONDON


CONTENTS

SMART, John, B.Sc., Ph.D., F.R.E.S. The classification of the Simuliidae (Diptera) 463-532

LONDON:
PUBLISHED BY THE SOCIETY AND
SOLD AT ITS ROOMS, 41, QUEEN'S GATE, S.W.7

Price £1 0s. 0d.
THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

Founded, 1833. Incorporated by Royal Charter, 1885.

PATRON—His MAJESTY THE KING.

OFFICERS and COUNCIL for the SESSION, 1945–1946.

Prof. G. D. HALE CARPENTER, M.B.E., D.M., President.

Francis Hemming, C.M.G., C.B.E.
O. W. Richards, M.A., D.Sc.
C. B. Williams, M.A., D.Sc.

A. WEITZ, Treasurer.

N. D. RILEY, Secretary.

Other Members of Council.

E. A. Andrews, M.A.
C. H. Andrews, F.R.S.
E. A. Cockayne, M.A., M.D., F.R.C.P.
J. W. EVANS, M.A., D.Sc.
W. J. Hall, D.Sc.
H. E. Hinton, B.Sc., Ph.D.


Finance and House Committee.

Francis Hemming, C.M.G., C.B.E. (Chairman).

Prof. H. G. Champion, C.I.E., M.A.
J. W. Evans, M.A., D.Sc.

Publication and Library Committee.

W. J. Hall, D.Sc. (Chairman).

K. G. Blair, D.Sc.
H. E. Hinton, B.Sc., Ph.D.
B. M. Hobby, M.A., D.Phi.

Committee on Generic Nomenclature.

Francis Hemming, C.M.G., C.B.E. (Chairman).

W. A. F. Balfour-Browne, F.R.S.E.
K. G. Blair, D.Sc.

Committee for the Protection of British Insects.

J. C. F. Fryer, O.B.E., M.A. (Chairman).

Capt. E. Bagwell-Purefoy.
R. B. Benson, M.A.
E. A. Cockayne, M.A., M.D., F.R.C.P.
Col. F. A. Labouchere.

The Executive Officers of the Society are ex-officio members of all Committees.

DELEGATES OF THE SOCIETY TO:

1. British National Committee for Biology (Royal Society).
   Dr. I. B. Wiglesworth, F.R.S.E., appointed 1943.
2. Local Committee of Management of Wicken Fen.
   Mr. H. M. Edelsten (nominated by Committee for the Protection of British Insects).
3. National Trust for Places of Historic Interest or Natural Beauty.
   Mr. H. M. Edelsten, appointed 1944.
   Mr. W. Fassnidge, appointed 1934.
5. New Forest Joint Committee.
   Mr. W. Fassnidge, appointed 1939.
   Dr. F. J. Killington, appointed 1939.
   Dr. C. B. Williams, appointed 1937.
7. Biology War Committee.
   Prof. P. A. Buxton, F.R.S., appointed 1941.
   Dr. W. H. Thorpe, M.A., Sc.D., appointed 1944.
THE CLASSIFICATION OF THE SIMULIIDAE (DIPTERA)

By John Smart, B.Sc., Ph.D., F.R.E.S.

Department of Entomology, British Museum (Natural History).

Manuscript received 11 October, 1944.

(Read 27 April, 1945.)

I. Introduction

1. Notes on earlier classifications of the family
2. Enderlein's work of 1921-1937
3. Edwards' work of 1915-1939
4. Proposed classification

II. Systematic

1. Family Simuliidae
2. On the genus Simulium (sensu lato et antiquo)
3. Sub-Family Parasimuliinae
4. Genus Parasimulium
5. Sub-Family Simuliinae
6. Genus Prosimulium
7. Genus Cephia
8. Genus Austrosimulium
9. Genus Gigantodax
10. Genus Simulium (restricted)

III. Key to the Genera of Simuliidae

IV. Catalogue of the described species of Simuliidae

V. Summary

VI. References

Addendum

Till 1906 no entomologist had ever questioned the advisability of regarding all living species of the Dipterous Family Simuliidae—the Black-Flies or Buffalo Gnats—as belonging to but one genus, Simulium. Splitting commenced in 1906 with a tentative proposal to regard the genus as comprising two sub-genera. Now entomologists find themselves on the horns of a dilemma because they have a choice between two proposed systems of classification within the family. Dipterists, whose views are entitled to respect and careful if critical examination, put these forward, and both have been followed by certain other workers. Many practical entomologists, especially those primarily interested in applied entomology, faced with this difficulty, elect to follow the older tradition and treat the family as containing only Simulium (sensu lato).

The earlier of the two classifications referred to above is Enderlein's. In 1921 Enderlein proposed to recognise no less than fifteen genera in place of the three segregates that were the most that any previous author had suggested. This same author continued his studies of the family and by 1937 further subdivision had resulted in a classification recognising no fewer than fifty genera distributed amongst seven sub-families.

On the other hand Edwards, in 1931, had proposed to recognise but two genera within the family, one of which he divided into seven sub-genera; later, in 1934, he reduced the sub-genera to five.

The perplexity of the entomologist faced with a choice between two such systems is well illustrated by a number of accounts of the genus Simulium. In the course of his studies of the genus in the Western United States, Richard E. Hart suggested a number of species, but all of these were later transferred to other genera.}

Trans. R. Ent. Soc. Lond. 95. Part 8. (Dec. 1945.)
classifications is considerable. Neither system has been fully expounded in its most recent form and the information about them is scattered in a variety of publications.

In the present paper the classifications proposed by Enderlein and Edwards are examined, and a revised classification is proposed and discussed in some detail. The work of other authors who have contributed to our knowledge of the family is considered in the discussion of the synonymy.

No monographic account of the family Simulidae exists. This state of affairs is another reason for reviewing the classification of the family. The addition of a catalogue of the described species may aid other workers to extend our knowledge of the family.

(I) Notes on Earlier Classifications of the Family.

At the beginning of the nineteenth century the genus Simulium was erected by Latreille (1802 : 426) who, at the time, assigned only one species to it. Before this other authors, including Linnaeus, had described species of Simulidae but had placed them in a variety of genera including Culex, Triplura, Musca, Rhagio, Scatopsea and Chironomus. Meigen (1800 : 19) had published the generic name Melasina, but it was not till 1908 that this was recognised as being possibly synonymous with Simulium, and no species were assigned to it till that date. Meigen (1803 : 263) erected the genus Atractocera and included one species therein, about the identity of which there is some doubt. However, the following year (1804 : 94) he included six species in Atractocera that were undoubtedly Simulids. Further notes about the above generic names will be found at page 477 where the question of generic synonymy and the identification of the genotypes is considered. Later Meigen (1818 : 289) adopted Latreille's Simulium as the name for the genus and sank his own Atractocera as a synonym. Thenceforward, until 1906, when Roubaud proposed to split the genus into two sub-genera, the genus Simulium was well recognised as a discrete, clearly defined group of Diptera, and when the group was designated a family, the Simulidae, it was regarded as containing but one genus, Simulium.1

Roubaud (1906) was the first author to propose a division within Simulium and subsequent to his work Surecouf & Gonzalez-Rincones (1911), Malloch (1914), Dyar & Shannon (1927), Enderlein (1921 et seq.), Tonnoir (1925), Baranov (1926 et seq.), Edwards (1931 and 1934), and Rubtzov (1937 and 1940) have all made suggestions concerning the internal classification of the family. The actual characters upon which these authors based the segregates of their classifications are discussed elsewhere in this paper but brief statements of their individual classifications are given below so that they can be referred to later.

Roubaud (1906) : Simulidae with one genus Simulium containing two sub-genera Pro-Simulium (sub-gen. n.) and En-Simulium (sub-gen. n.).

Surecouf & Gonzalez-Rincones (1911) : Simulidae with three genera Prosimulium Roubaud, Ensimum Roubaud and Simulium Latreille (restricted).

Malloch (1914) : Simulidae with three genera Parasimulium (gen. n.), Prosimulium Roubaud and Simulium Latreille (restricted).

Dyar & Shannon (1927) : Simulidae with four genera Parasimulium Malloch, Prosimulium Roubaud, Ensimum Roubaud and Simulium Latreille (restricted).

1 Excepting the two fossil genera Pseudosimulium Handlirsch (1906) and Simulidium Westwood (1854); see page 475.
Enderlein (1921a et seq.) as at 1937²: Simulidae divided into seven sub-families containing 50 genera as follows:

**Prosimulinae** containing *Prosimulium* Roubaud, *Taenioperna* Enderlein (1925), *Cnephia* Enderlein (1921), *Helodion* Enderlein (1921) and *Parasimulium* Malloch.

**Hellichininae** containing *Hellichia* Enderlein (1925) and *Astega* Enderlein (1930).


**Cnesiinae** containing *Archinesia* Enderlein (1934) and *Cnesia* Enderlein (1934).

**Stereopterinae** containing *Stereopterum* Enderlein (1930), *Mallochella* Enderlein (1930) and *Gigantodax* Enderlein (1925).


**Tonnaire (1925):** Simulidae containing three genera *Prosimulium* Roubaud, *Simulium* Latreille (restricted) and *Austrosimulium* (gen. n.); based on the study of a restricted fauna.

**Baranov (1926 et seq.):** In general classification followed Enderlein but only dealt with a restricted fauna. He proposed (1926) the following new sub-genera *Pseudosimulium*, *Pseudodagmia* and *Pseudonevermannia*. Later (1935) he proposed the name *Danubiosimulium* in a sub-generic sense but raised it to generic status three years later (1938) at the same time that he erected the genus *Echinosimulium*.

**Edwards (1931 and 1934):** In 1931 he regarded the family Simulidae as containing two genera *Parasimulium* Malloch and *Simulium* Latreille (restricted) and divided the latter genus into seven sub-genera *Prosimulium* Malloch, *Cnephia* Enderlein, *Gigantodax* Enderlein, *Austrosimulium* Tonnaire, *Eusimulium* Roubaud, *Morops* Enderlein and *Simulium* Latreille (restricted). Later in 1934 he indicated that he thought that the last three sub-genera could only be regarded as one, *Simulium* (restricted).


² The latest paper on Simulidae by Enderlein appears to be that of 1937.

The work of the first four authors, whose classifications are outlined above, centres round the status of three genera; their work is therefore dealt with under these genera, *Parasimulium* at page 479, *Prosimulium* at page 480, and *Eusimulium* at page 484. Enderlein's work is considered immediately below and Edwards' at page 470. Tonnoir's work is dealt with under *Astrosimulium* at page 486, and Baranov's under *Simulium* at pages 478 and 494.

Rutlov's earlier classification (1937) contained seven genera *Parasimulium* Malloch, *Prosimulium* Roubaud, *Astrosimulium* Tonnoir, *Gigantolus* Enderlein, *Helodon* Enderlein, *Eusimulium* Roubaud and *Simulium* (restricted), with the last two divided into seven and ten sub-genera. His later classification (1940) approaches the one proposed in the present paper, except that his *Simulium* is divided into *Cnephia* and *Simulium* (restricted), and that recognition is not given to his other subgeneric divisions.

Twinn (1936), dealing with a restricted North American fauna, adopted Edwards' (1931) classification, except that he synonymised *Cnephia* with *Eusimulium*.

(2) Enderlein's Work of 1921–1937.

Prior to 1921, Enderlein's only contribution to the systematics of the *Simulidae* had been the description of a single species, *Simulium speculicentre* Enderlein (1914), from the Seychelles Islands (Percy Sladen Expedition). In 1921 Enderlein published four papers (1921a, b, c and d) in which he elaborated a classification for the family, dividing it up into two sub-families, sub-dividing one of these into two tribes and distributing the species amongst no less than fifteen genera. He accepted *Parasimulium* Malloch (1914), *Prosimulium* Roubaud (1906), and *Simulium* Latreille (1802) and in addition he erected twelve new genera of his own: he regarded *Eusimulium* Roubaud as a synonym of *Simulium* (following Malloch (1914); see further at page 485).

In two papers, each of which contained practically the same matter, Enderlein (1921a and c) presented a key to the genera and gave lists of species included therein. While both these papers outlined the classification, two other papers of that year (1921b and d) must be considered along with one or other of them.3 Enderlein's lists of species were by no means a complete catalogue but apparently contained those with which he was, or thought he was, familiar. Furthermore the keys were defective because certain new genera were known only in one sex and the keys made use of characters of both sexes.

Enderlein's classification of 1921 may be summarised as follows:—

Family: *Simulidae*.

Sub-Family: *Prosimulinae*.


Sub-Family: *Simulinae*.

Tribe: *Nevermanniini*.


---

3 That is for those interested in the scheme of classification as such. Those interested in nomenclatural minutiae will have to consult all four (see footnote on pages 487–488).
Tribe: Simuliini.


The genotypes of the genera are given in the systematic part of the present paper but it may be noted that in 1921 Enderlein gave *reptans* Linnaeus as genotype of *Simulium* Latreille and later, in 1930, adopted the generally accepted view and gave *colombascensis* Fabricius (see page 477).

This earliest classification of 1921 was followed by a large number of papers (Enderlein 1921e-1929e) in which many new species were described and new genera erected. It was not, however, till 1930 that a synopsis incorporating the results of these papers appeared.

Enderlein (1930) once again gave a key to genera and lists of the species in them. The paper suffered from the same defects as that of 1921. In the classification presented in 1930 he divided the family up into six sub-families, dispensed with tribal categories, and distributed the species amongst no less than thirty genera. This increase in the number of genera was entirely due to Enderlein's own activities. He continued to regard *Ensimulium* Roubaud as a synonym of *Simulium* and he found no place in his scheme for *Austrosimulium* Tonnoir.4

Subsequent to 1930 Enderlein has expanded the number of genera to a total (at 1937—the last known paper) of fifty; has increased the number of sub-families from six to seven; and has inserted tribal categories in two of the sub-families of the 1930 scheme (see below). These additional genera and their associated species, where new, were described in Enderlein's papers (1931-1937). The general progress of the whole classification may be gathered from the dates attached to the genera in the summary of the Enderleinian classification on page 465.

Enderlein's (1936b) incomplete tribal system of *Nevermanniinae* and *Simuliinae* is as follows:—

**Nevermanniinae**

1. Nevermanni
   *Chelonebath, Cuetha* and, it is to be inferred, *Nevermannia*.

2. Friesi
   *Disypelmoza, Acropogon* and, it is to be inferred, *Friesia*.

3. Wilhelmii
   *Schönbaueria, Pselaphochir, Notolepria, Ectonnaspis*, and, it is to be inferred, *Wilhelmia*.

**Simuliinae**

1. Simuli
   *Simulium, Psaronichempa, Pirolaxina, Thyrsopelma* and *Metomphalus*.

2. Odagmi
   *Trichodagmia* and *Odagmia*.

Enderlein has not yet stated any tribal characteristics except that the genera, as shown above, are included in the tribes; his tribal proposals may therefore be disregarded.

4 It cannot of course be inferred that Enderlein has ignored the work of certain authors merely because he refrains from mentioning any of the species described by them. If this non-mention of species were taken to mean this, the remarkable fact would become evident that Enderlein (at 1930 and during later years) has ignored the work of Dyar & Shannon (1927), Pomeroy (1916-22), Gibbins (1933-41), de Meillon (1930 onwards), some of Lutz (1909-28), and much of Knab (1911-15) as well as Tonnoir (1925)!
In criticising the work of Enderlein, the criteria that he used in making his
generic segregates, the criteria of other authors which he has not used or has
criticised, and the general methods of his work must be examined; frequently
all can be demonstrated in the same example.

Enderlein has always ignored the use of the male genitalia of Simulidæ
either for generic or specific discrimination. Admittedly other authors have not
yet been able to make generalisations as to the generic value of the features of
these parts, but no competent modern author would, today, describe a male
Simulid without figuring and describing various parts of the male terminalia.
Many authors also pay great attention to the female genitalia.

The presence of a little flap on the inner side of the apical end of the basis-
tarsus of the hind leg in many species and of a notch on the dorsal side of the
second tarsal segment of the same leg, had been noted by Roubal in his first
attempts to split the genus Simulium. Subsequent authors all appreciated the
seeming importance of these two characters but it remained to Enderlein
(1930) to give these features the now internationally accepted names of
"calcipala" and "pedisculus" respectively. Enderlein (1930) used character-
istics of the calcipala and the pedisculus to differentiate his sub-families and thus,
indirectly, his genera. While the condition of the calcipala and the pedisculus is
unquestionably of some value it should be noted that all stages in their develop-
ment are to be found in the different species of Simulidæ, ranging from
complete absence (Pseudozióia) to the almost spatulate calcipala of Gigan-
tobius, and the deeply incised pedisculus of some species of Simulium.

Enderlein made great use of the shape of the fore-leg basis-tarsus, the hind-
leg album and the hind-leg basis-tarsus.

In some species one or other, or more, of these segments may be obviously
parallel-sided or may be definitely expanded. Intermediate conditions occur
and it is sometimes difficult to know when a leg-segment ceases to be parallel-
side'd and commences to be "slightly spindle-shaped", both of which conditions
are given as generic characteristics by Enderlein.

Of Pseudozióia incrustum Malloch only the male is known; it has di-
cheptic eyes, a character which, coupled with other features of this genus, is
electronically important. Enderlein, however, has not commented upon it, being
apparently unaware of the fact that Malloch (1914) described the only known
specimen as a female. While Kuhn (1915) pointed out that it was a male (see
Underline on page 4759). Edwards (1931) described Simulium (Gigantobius)
foexiens in which the males had dichoptic eyes, and at the same time he
described Simulium (Cyicoplia) gynaecidum, of which he considered the type
series to be a series of gynaecidiform forms, all of which had the eyes in the
dichoptic condition. In neither of these species were the facets of the
compound eyes differentiated into two areas of different-sized facets as is usual
in male Simulium (see page 4759). Enderlein (1932, 2753) noted upon the
dichoptic male eyes without differentiation of the facet size in Pseudozióia, found
that the type series of Pseudozióia contained dichoptic males, erected two new
genera, Hendrinia and Cavesia, to receive the two species, and finally placed
both these genera in a new sub-family, Cavesiacæ, characterised by the scalar
features mentioned above. That Edwards (1931) placed these two species in
Gigantobius and Ciccoplia (used in a sub-generic sense) seems to have maintained
mind in Enderlein comparing with the opportunity of segregating the two
species in a new sub-family named from the other species to which their other

56. Malloch in his classification of 1914 does not use these two characteristics.
characteristics indicated relationship. He does not give any of the generic or sub-familial characters that may be present in the female of either species. Dampf (1944) has recently reported that in Simulium exogeta, Roubaud, there are two forms of male, one with the usual holoptic eyes and one with the eyes in the dichoptic condition. When confirmed, this discovery will finally expose the folly of Enderlein's proposals to make the dichoptic male eye a sub-familial characteristic.

Roughly speaking, Enderlein's method was to take the latest morphological character that had come to his attention and, so far as possible, to divide up every pre-existing segregate by its use. For example, prior to 1934 Enderlein paid no attention to the hairy or naked condition of the upperside of the basal section of the radius. Dyar & Shannon (1927) (see page 455) drew attention to the apparent importance of this character and defined Eumauidium Roubaud on the basis of it. Practically every author on the Simulidae after that date made use of the character till 1934, when Edwards (1934) showed that too high a value had been placed upon it. It was unfortunate that Enderlein chose to commence using the character when he did, otherwise his omission to utilise it might have been put down to prescience of its value! However, Enderlein (1934a) proceeded to split off Dasypelma (new genus) from Freisa, Thamnopelma (new genus) from Simulium (restricted) and to differentiate Trochopelma (new genus) from Odagymn mainly on the basis of this character (see further on page 492). The first pair of genera belong to the Nevermanninae of Enderlein, while the last two pairs belong to his Simulinae.

Following up this promising line, Enderlein found characteristics of generic significance in the trichiation of the sub-costa, distal section of the radius and radial-sector. Once again Enderlein found those characters of the sub-trichiation efficacious in differentiating genera, many of them new, in these different sub-families of his system of classification. Internal evidence in Enderlein's papers shows that he must have become cognizant with the use of the trichiation of the basal section of the radius from Edwards' (1931) paper on Patagonian Simulidae.

Enderlein's (1930) key to the sub-families and genera of the Simulidae illustrates his tendency to apply exactly the same criteria to all segregates. After keying out the six sub-families (of 1930), he separately keys out the genera of each. In each of these keys to the genera, except the first, the next character divides the genera into those containing species with the female claws toothed and those with female claws untoothed. 8

8 Enderlein (1921:217) followed Malloch (1914) in regarding Eumauidium as a synonym of Simulium as then restricted by himself. He (1927 and 1930) persisted in this view.

It is as well to remember that the unbranched radial-sector joins the costa at such an acute angle that it is very difficult to say precisely where radial-sector ends and costa begins in the region of the gradual junction between the two. A consequence of this might be that macrotrichia of the costa might, by a process of wishful thinking, appear to be on the radial-sector.

The first sub-family is Papuanellinae. Enderlein includes Periadenium Malloch in this sub-family and the first character of the key puts Periadenium on characters of segmentation, and the untoothed claw is mentioned as a correlative character. The familiar character comes later when Holmesia is separated from Periadenium and Jassopelma.

In the keys to the genera of three of the sub-families, Sarmetinea, Naumanninae and Simulinae, Enderlein commences (1933) the differentiation of genera on the characteristics of the female only. It is then impossible to run through these keys unless associated females are at hand. Curiously enough, male characteristics are given in some subsequent complements.

Sarmetinea, the seventh Enderleinian sub-family, was erected in 1933.
Enderlein made great use of the comparative lengths, size, shape and toothed or untoothed condition of the claws in segregating his numerous genera. In many cases the condition of the claws differs between the sexes, which is in itself an objection to laying too much stress on them as supra-specific characters. If Enderlein's prominent use of the claws to split up his sub-families were followed the four fairly uniform genera, *Prosimulium*, *Cnephia*, *Austrosimulium* and *Simulium*, as restricted in the present paper can be immediately split, but whether genera that are cohesive on examination of a variety of other characters should be so split is a matter of opinion: Enderlein would obviously proceed to do so at once.

Finally the liberty is taken of drawing attention to two particularly instructive cases of Enderlein's procedure. Edwards (1931: 154) identified material taken by himself in Patagonia and South Chile as *Simulium* (*Simulium*) *nigristrigatum* (End.) (= *Pternaspatha nigristrigata* End. (1930)). Edwards had a paratype of Enderlein's species before him, and he pointed out that it possessed a small sub-basal tooth on the female claw; both the paratype and Edwards' specimens lacked the calcipala but, according to Edwards, *nigristrigata* End. was obviously related to *Simulium* (*Simulium*) *varipes* Philippi (1865), *nemoralis* Edw. (1931) and *simile* Silva Figueroa (1917), all of which possess a calcipala and toothed female claws. Consequently Edwards (1931) placed all four species in his sub-genus *Simulium* (restricted).

Enderlein (1934a) dealt with Edwards' findings of 1931 as follows: Firstly he found that the paratype of *nigristrigatum* End. sent to Edwards differed from the remainder of the original series in his hands and so he made a new species *edwardsi* (= *Pternaspatha nigristrigata* End. of Edw. (1931)) and placed it in *Acropogon*, a new genus erected in the same paper. Secondly he took *varipes* Phil., which he had previously placed in *Friesia*, and made it genotype of a new genus *Dasypelma*, which differed from *Friesia* in having the female claw toothed and the basal section of the radius hairy.

In the same paper (1934a: 280) on one page he assigned *nemoralis* Edw. (1931) and " *similis* Edw. (1931)" (i.e. *simile* Silva of Edwards) to *Acropogon*, while on another page (1934a: 283) he assigned the same *nemoralis* Edw. (1931) to a new genus *Psilopelmia*. Enderlein (1936b: 119) realised he had made a mistake and gave *Psilopelmia nemoralis* (Edw.) (1931) as a synonym of *Acropogon nemoralis* (Edw.) (1931) but he was careful not to draw attention to the double assignment made in 1934; he made it appear that 1936 was the time at which he had realised that *nemoralis* belonged to *Acropogon* and not to *Psilopelmia*!

(3) Edwards' Work of 1915-1939.

Edwards made important contributions to our general knowledge of the Simulidae of the Palaeartic, Oriental, Neotropical and Pacific regions. Furthermore he was intimately acquainted with the work of Puri on the Indian species, Tonnoir on the Australian and New Zealand, and de Meillon and Gibbins on the African species, having constant close personal contacts with all these workers. In view of Edwards' wide knowledge of the species of Simulidae throughout the world, it is a matter of infinite regret that he never monographed the family. However, his views on the general classification of the family may be gathered from two papers that he published on the species of Patagonia and South Chile (1931) and those of Java and Sumatra (1931). The classification adopted in the present paper is largely that proposed by Edwards, though different taxonomic status is accorded to the segregates proposed by him.
Edwards (1915), in his earliest paper on the Simuliidae, dealing with the British species, found it "not advisable to follow Malloch and Roubaud in sub-dividing the genus Simulium." Five years later, in his subsequent paper (1920) on the British species, he adhered to this decision, but this may have been to preserve continuity with his earlier paper rather than from conviction because, when describing three new species of Palearctic Simuliidae in the next year, he (1921) used Prosimulium and Simulium (restricted) as sub-genera. Edwards’ papers of 1931 and 1934 indicated his acceptance of certain generic and sub-generic segregates within the family.

This latest classification of Edwards’ has been outlined at page 465. In 1931 he indicated that while prepared to accord generic status to Parasimulium Malloch, he regarded all species of Simuliiidae, other than P. farcalvum Malloch, as falling into a single genus, Simulium Latreille, which he proposed to divide into seven sub-genera. In 1934 he did not elaborate his classification of 1931, but instead presented evidence that the sub-genera, Morops, Eusimulium and Simulium (restricted) could not be clearly demarcated from each other, though the last two remained useful categories when dealing practically with the identification of a localised fauna.

Edwards’ main contribution to the systematics of the Simuliidae, apart from the description of many new species and the redescription of older ones, was (1931) in drawing attention to certain features, on the basis of which after dividing the family into two genera, Parasimulium and Simulium, he subdivided the latter into seven sub-genera, Prosimulium, Cnephia, Austrosimulium, Gigantodax, Simulium (restricted), Morops and Eusimulium. He redefined these segregates in the light of his discoveries. Amongst the points to which Edwards then drew attention were:

(a) That a basal cell was present in the wing field of Prosimulium and Cnephia but absent in the other groups.

(b) That the macrotrichia of the anterior wing veins were all longish and hair-like in Parasimulium, rather shorter and bristle-like in Prosimulium, and of this shorter bristle-like type intermixed with spiniform macrotrichia in all the other segregates.

(c) That in Prosimulium the anterior branch of the furcate radial-sector (R₂₃) was a concave vein naked on its upperside while the posterior branch (R₁₅) was a convex vein bearing macrotrichia on its upperside.

(d) That in species of Austrosimulium and Gigantodax that he was able to examine, the unbranched radial-sector with macrotrichia on the upperside distally was a convex vein, i.e., R₁₅, R₂₃ having atrophied.

(e) That in species of Simulium and Morops known to him the distal part of the radial-sector was naked and a concave vein, i.e., R₂₃, R₁₅ having atrophied.

(f) That in species of Eusimulium known to him (as he was defining the subgenus in 1931) the distal section of the unbranched radial sector was a convex vein haired above as in Austrosimulium and Gigantodax.

(g) That there were good reasons for depreciating the value placed upon the hairy or naked condition of the upperside of the basal section of the radius (see further on page 490) to which Dyar & Shannon (1927) attached much importance.

Points (e) and (f) must be accepted with reservation. Edwards (1934) himself later stated that he could not maintain Eusimulium, Morops and Simulium (restricted) as separate sub-generic segregates (see further below). Enderlein (see above at page 469), on the other hand, has discovered generic characteristics in the trichiation of nearly all the anterior wing veins!
That there were reasons for depreciating the value that Enderlein (1930) had placed upon the calcipala and pedisulcus (see further on page 468).

Edwards (1934: 131), by dissecting larvae of *Simulium fuerborni*, was able to demonstrate the presence in the developing wing of a forked radial-sector, a basal cell and the absence of any sub-median fold. The imaginal wing of *S. fuerborni* has a simple radial-sector, no basal cell, and a sub-median fold. Edwards thus proved that the forked radial-sector of *Prosimulium* and *Parasimulium* and the presence of a basal cell in the wing of *Prosimulium*, *Cnephia* and *Gigantodax* were primitive features and also that the sub-median fold was such and not a true vein.

Edwards (1931 and 1934) realised that the features to which he drew attention, and some of those of other authors which he re-emphasised, had considerable phylogenetic significance, but he was diffident in drawing conclusions from them, and contented himself with the classification outlined at page 465. His aim was to produce a handy practical arrangement that would, to some extent, show true relationships and be in accordance with his discoveries, rather than to present any phylogenetic statement. This was regrettable because the material that he presented undoubtedly does allow a tentative classification to be drawn up around his segregates (genera and sub-genera) though with some alterations to their status. This tentative classification is set out below:

**Family: Simulidae**

Two sub-families:—

1. **Parasimulinae**: R₁ joins costa at middle of latter’s length, macrotrichia of anterior wing veins hair-like; males dichoptic; no calcipala, no pedisulcus. One tribe:—
   a. Parasimulini. One genus:—
   i. *Parasimulium*.

2. **Simulinae**: R₁ joins costa well beyond middle of latter’s length, macrotrichia of the anterior wing veins bristle-like; males, with few exceptions, holoptic.¹³ Three tribes:—
   b. Prosimulini: R₁ forked or swollen at its tip, basal cell present; may be trace of pedisulcus, may be very small calcipala. Two genera:—
   ii. *Prosimulium*: R₁ forked, only bristle-like macrotrichia on the anterior wing veins; no calcipala, no pedisulcus.
   iii. *Cnephia*: R₁ unforked but just slightly swollen at the tip, both bristle-like and spiniform macrotrichia on the anterior wing veins; very small calcipala, in some a slight indentation as pedisulcus.
   c. Austrosimulini: R₁ simple but a convex vein with macrotrichia on its upper surface distally (i.e. is R₁₂), no basal cell; calcipala present. Two genera:—
   iv. *Austrosimulium*: antenna ten (or nine) segmented; Cu₂ and Ana simple; pedisulcus present.
   v. *Gigantodax*: antenna eleven segmented; Cu₂ and Ana straight; no pedisulcus.
   d. Simulini: R₁ simple, no basal cell, basal section of radius naked or bearing macrotrichia above, distal section of R₁ naked or bearing macrotrichia above, pedisulcus present, calcipala present (with exceptions).¹⁴ One genus:—
   vi. *Simulium*,¹⁵

¹⁰ There are two, or possibly three, species with dichoptic males. Notes on these will be found at pages 468 and 476.

¹¹ The exceptions are the four species belonging to four of the five genera that comprise the Enderleinian sub-family Ectemninae. Notes on these will be found on page 493.

¹² That is the segregate equivalent to the sub-genus *Simulium* of Edwards (1934) = sub-genera *Simulium* + *Morops* + *Eosimulium* of Edwards (1931).
Features of the early stages give some support to the above tentative tribal classification. These are mentioned briefly here; further details will be found in the Systematic part of the present paper.

Nothing is known of the early stages of *Parasimulium*.

The oviposition habits of one species of *Cnephia* are known. It lays its eggs singly or in small groups, not in the compact masses usually associated with *Simulium*. In *Prosiumilium* the oviposition habits are unknown but negative evidence suggests that they do not conform to the usual habits of the family. In *Prosiumilium* and in some *Cnephia* the cocoons are without the definite form usually associated with the family. The pupal respiratory organs in these two genera are furnished with branching filaments, which in *Cnephia* number 12 to 50 terminally and in *Prosiumilium* from 15 to 50 or 60.

The eggs of *Gigantodax* are unknown. Those of the one species of *Austrosimulium*, of which the habits are known, are laid in the usual masses. The cocoons in both genera are of the usual form associated with the family. The respiratory organs of *Austrosimulium* conform to one type consisting of a stiffish stalk from which spring numerous very fine filaments. In *Gigantodax*, as far as they are known, the pupae have respiratory organs with eighteen filaments in each arranged in a particular way and not in the dendroid manner of *Prosiumilium* and *Cnephia*. In all known larvae of *Austrosimulium* and *Gigantodax* the sclerite that is found in the anal region forms a complete ring round the anus; this sclerite forms an incomplete ring in the known larvae of the other genera.

In *Simulium* (restricted) eggs are always laid in masses; cocoons always have a definite shape; pupal respiratory organs tend to have less than a dozen ultimate branches arranged in very varied patterns, but the number and arrangement of branches is usually constant in any particular species.

Early stages thus provide some evidence that the tribes *Prosimulini* and *Austrosimulini* are realities and distinct from the *Simulini*; in the *Simulini* the lack of definite common characteristics and the existence of a variety of types within the tribe which, however, do not lend themselves to isolation in segregates, suggests that the group in the tribal sense used above is an artificial one.

The tentative tribal classification suggested above receives some further support from the geographical distribution of the proposed tribes. Firstly, *Prosiumilium* is confined to the Holartic, while *Cnephia* is Holartic with an extension down into the Neotropical region and four Australian species. Secondly, *Gigantodax* is found in the Andean region of South America, with a single species recently recorded from Mexico, and the former region is the only place other than Australia, Tasmania and New Zealand where *Austrosimulium* is found. The cosmopolitan distribution of *Simulium* (restricted) points, however, to a lack of reality in *Simulini* as a tribe.

This tribal scheme cannot, however, be adopted. The loose definition required for the *Simulini* with its single genus *Simulium* indicates that this genus is not fully understood. It may be of polyphyletic origin; possibly a redefined *Eusimulium* may be eventually cut out from it. However, as has been mentioned, there are good reasons for not following the sub-divisions previously proposed whereby *Eusimulium* (as defined by Dyar & Shannon (1927) and used by Edwards (1931)) was regarded as a distinct segregate from *Simulium* (restricted).

Enderlein (1930, etc.) dealt with the situation by dividing the greater part of the segregate *Simulium* of the above classification into two groups (sub-families *Nevermanniinae* and *Simuliinae*), one containing 20 Enderleinian
Dr. John Smart on the classification

genera and the other 13! These two segregates were separated mainly by the “normal” fore-basitarsus ascribed to the NEVERMANNINAE, and its flattened or swollen condition in SIMULIIDAE. This character was used as a subsidiary one by Dyar & Shannon (1927) to distinguish their EUSINULUM from their SIMULID (restricted). Previously it had been used by Edwards (1915 and 1920) to distinguish his “group A” and “group B” of species within SIMULID (sens. lat.) and it was used by him (1931, etc.) at later dates to differentiate EUSINULUM and SIMULID (restricted) as sub-genera.

A further lack of homogeneity in the segregate SIMULID of the above classification is the presence within it of four of the five monotypic Enderleinian genera that constitute Enderlein’s sub-family ECTENIDIINAE (the fifth genus is a synonym of Crenphila). These genera are stated to lack a calcipala but to possess a pedisulcus. All the other species included in SIMULID of the above classification have both calcipala and pedisulcus. Since, however, the species comprising the four genera show characteristics which ally them to species that possess a calcipala, and are obviously SIMULID as defined in the above classification, it seems difficult to give them separate taxonomic status on the basis of the lack of an organ, the calcipala, which varies very considerably in the extent to which it is developed. There is also a suspicion that though Enderlein has stated that they lack it, they may in fact have a small insignificant calcipala. The matter is dealt with in greater detail at page 493.

It is self-evident that a large group of species in which one author (Edwards 1931 and 1934) finds good reasons for closing up taxonomic ranks till one sub-generic segregate remains, while another (Enderlein 1930, etc.) has to continue splitting it up till 50 generic segregates have been created, is a difficult one. When more is known about the early stages of the species now assigned to SIMULID (restricted), it may be possible to ascertain whether or not features of these stages give any support to any of the Enderleinian segregates. It is certain that, pending receipt of such reinforcement of the relatively trivial characteristics used by Enderlein to differentiate his genera in the adult stage, they cannot be given status comparable with that accorded to such clearly defined groups as those constituting PROSIMULID, Crenphila, AUSTROSINULID and GIGANTIDEA. Unfortunately it so happens that knowledge of early stages is least just amongst those very species that Enderlein has himself described and so often used as genotypes of his own genera, some of which are conspicuous for the small numbers of species of other authors assigned to them by Enderlein, and the extremely small number of specimens available.

(4) Proposed Classification.

Any classification can be attacked from one direction or another. In the SIMULIDAE the “lumper’s” use of the single genus SIMULID undoubtedly results in a very large number of species being included in a single genus which themselves fall into segregates within that genus. On the other hand, the “splitter’s” method of dealing with the family, as exemplified by Enderlein, depends in many cases on the use of differences in structure that are of such small biometrical magnitude that some workers have difficulty in appreciating them at all, a point that is quite distinct from the possibility of variation within these small biometrical limits. Edwards’ introduction of sub-genera tends to minimise undoubted morphological differences that do exist amongst various segregates within the family.

The brevity of Enderlein’s diagnoses of genera, and the often incomplete nature (male genitalia never described) of many of his descriptions of genotypic
species, make it difficult to identify his genera or the species belonging to them without access to authenticated material that has passed through his hands. Many species that are genotypes of monotypic Enderleinian genera are known in one sex alone and from a unique specimen, or a very small number; these genotypes are also scattered in different institutions.

It is therefore proposed to follow Edwards (1931 and 1934) in delimitation of segregates within the family but to differ from him in the taxonomic status accorded to them. Furthermore it is proposed to divide the family Simuliidae into two sub-families, Parasimulinae and Simulinae; the former to comprise the genus Parasimulium Malloch, the latter the genera Prosimulium Roubaud, Cnephia Enderlein, Austrosimulium Tomoir, Giganodon Enderlein and Simulium Latreille (restricted and comprising the sub-genera Simulium, Ensimulium and Morops of Edwards 1931).

It is not proposed to recognise any tribes or sub-genera.

II. Systematic.

(1) Family Simuliidae (Diptera).

Latreille's (1802) original definition of the genus Simulium reads as follows:

"Antennes à pointe plus longues que la tête, insérées entre les yeux, un peu conique, de neuf à dix articles, peu distincts, presque cylindriques. Palpes longs, courbés, de cinq articles. Museau avancé. Un succeur sensible.
"Exemples. Rhagio colombeaechenesi F."

Meigen's (1818) definition of the genus sensu lato et antiquo reads as follows:

"Antennae porrectae, cylindricae, undeconarticulatae: articulis duobus inferioribus discretis.
"Palpi erecti, incurvi, cylindrici, quadriarticulati: articulo primo breviore.
"Ocelli nulli.
"Aile latae incumbentes parallelae."

This definition is followed by a more lengthy description of the generic characters which it would serve no purpose to quote here.

The family is a very discrete one and, since the time of Latreille and Meigen, there has never been any difficulty in any author's mind in regarding the group either as a genus sensu lato et antiquo or as a family. Parasimulium seems the most primitive genus but is very imperfectly known (see page 479). Fossil Simuliidae add nothing to our knowledge of the family. Species from Baltic amber belong to living genera. Two species from the English Purbeck were placed in distinct genera, Pseudosimulium Handlirsch (not Pseudosimulium Baranov; see page 494) and Simulium Westwood but this seems to have been done on account of the imperfections of the fossils rather than the detection of actual characters of generic value. Rubtsov (1937 and 1940) has presented some phylogenetic and zoogeographical studies on the family which are, however, based on an acceptance of many of Enderlein's genera as sub-generic segregates.
Of the other genera recognised in the present paper, *Prosimulium* seems most primitive. Species of this genus bear a superficial resemblance to the *Bibionidae*, which has led some authors to include *Simulidae* in a superfamily *Bibionoidea*. However, species show certain obvious, if cryptic, affinities with *Chironomidae* and *Ceratopogonidae*, and to a lesser extent with *Culicidae*. The family is, however, quite distinct and there is a lack of species with characteristics that would obviously link them to other families.

The features of the family may be summarised as follows:

Small thick-set flies of from 3 to 6 mm. in length, with strong legs, characteristic antennae, characteristic wing-venation, belonging to the Nematocerous Diptera. Distribution, cosmopolitan.

Head in both sexes fairly hemispherical, as wide as thorax, closely applied to the latter but quite mobile on its short neck. Correct antennae relatively short, never as long as twice thickness of head and often less, 9-, 10-, 11-segmented, segments all very similar, cylindrical and close set. Compound eyes reniform, tending to surround bases of antennae, dichoptic in female, holoptic and with the upper facets enlarged in males (except in three or four species). No ocelli. Proboscis short, adapted for piercing with a slicing stroke of mandibles; all mouth-parts enter wound except labium, which is furnished with large soft labellae; mandibles as well as maxillae present in both sexes, though weak in males. Pendulous four-segmented palpi longer than proboscis. Proximal segment smallest, distal one narrowest and longest; a sensory organ present in 2nd segment in both sexes.

Thorax is arched, no transverse suture on mesonotum, scutellum small, postnotum rounded (not conical). Conspicuous unsclerotised or membranous area in upper episternite of mesothorax. Wings with anterior veins (C, Sc, R, R1, R2, and M) markedly thicker than posterior veins (M1, M2, Cu1, Cu2, An1 and An2); costa terminates before apex of wing, radial-sector (R1) and veins anterior to it to complete and all run into the costa, no discal cell or axillary vein; "sub-median fork," a remarkable forked vein-like crease, between M2 and Cu1. Legs short and strong, short tibial spurs usually present, basitarsus (= metatarsus) somewhat elongate, fourth tarsal segment with pulvilliform latero-apical expansions, feet with two claws.

Abdomen ovoid-cylindrical and without any externally visible waist attaching it to thorax, capable of very considerable distension to accommodate food or, in the case of females, developing ovaries. First segment scale-like and called "abdominal scale." Tergitae, apart from that of first segment which forms abdominal scale and that of ninth which take part in structure of genital mass, show a tendency to reduction in size; sternites show similar tendency.

Genitalia of both sexes sub-terminal in position; those of male not rotated.

Pupa aquatic, always enclosed in cocoon, made by larva of silk formed of secretion of salivary glands immediately prior to pupation. Pupa has a pair of respiratory organs arising from antero-lateral region of dorsum of pupal thorax.

Larva aquatic, amphipneustic and soft-bodied with well-chitinised head-capule and mouth-parts. In addition to usual mouth-parts there are a pair of very characteristic mouth-brushes used for collection of food. Antennae four-segmented but secondary annulations frequently cause number to be estimated as larger. Two eye-spots on each side of head.

13 *Prosimulium fuscum* Malloch (see pages 468 and 479); *Gigantolax feminina* Edwards (see pages 468 and 487); *Cycphina gymnandra* Edwards (see pages 468 and 484); and *Simulium nigripalpe* Boubaud according to Dampi (1944). This last case is particularly interesting in that Dampi claims to have found that in this species there are two forms of male, the one with the holoptic eyes of the usual type, the other with dichoptic eyes with no facet differentiation. The whole question of these dichoptic males will have to be further considered and investigated before the true systematic importance of the phenomenon can be gauged. (See also at page 469.)
There is a median prothoracic pro-leg, the tip of which is furnished with chitinised hooks; at posterior end of abdomen there is a sub-anal circle of radial rows of small chitinised hooks ("posterior sucker" of authors). Three protrusable anal gills present.

Larvae spin a web of silk made with secretion of salivary glands on sub-stratum. Locomotion over sub-stratum accomplished by means of characteristic looping motion involving use of mouth-parts and pro-leg as well as "posterior sucker" which is itself main organ of adhesion to sub-stratum.

Ova have characteristic rounded triangular outline when viewed along shortest axis. Usually laid in masses but at least one species (*Cnephia pescariae*, see page 483) lays them otherwise.14

(2) The genus *Simulium* Latreille sensu lato et antiquo.


Genotype: *Rhagio colombiachense* Fabricius (1787) by original designation of Latreille (loc. cit.).


As applied by Hendel (1908) and Coquillet (1910) but not as applied by Malloch (1914) and Stone (1941).

Genotype: *Tipula regelationis* Linnaeus of Meigen (1803) = *Simulium ornatum* Meigen (1818) (apud Meigen (1818)), this being the first named species associated with the genus by Hendel (1908-80) when synonymising it with *Atractocera* Meigen.


As applied by Meigen (1818), Hendel (1908) and Coquillet (1910) but not as applied by Malloch (1914) and Stone (1941).

Genotype: *Tipula regelationis* Linnaeus of Meigen (1803) = *Simulium ornatum* Meigen (1818) (apud Meigen (1818)), by original designation of Meigen (loc. cit.).


*Simulium* of all authors up to the appearance of Malloch's (1914) paper and of many after that date.


Genotype: *Simulium priscum* Westwood by original designation of Westwood (loc. cit.).


Genotype: *Simulium han圉dum* Brodie by designation of Handlirsch (loc. cit.).


Genotype: *Simulium colombiachense* (Schönbauer) = *Simulium colombiachense* (Fabricius) by original designation of Barnavot (loc. cit.).

Other synonyms of *Simulium priscum lato et antiquo* are the various genera considered below in the present paper and the various synonyms of these genera.


Schönbauer (1795) was aware of the existence of *Rhagio colombiachense* Fabricius but he believed he was describing as *Culex colombiachense* (frequently spelt *colombiachense* by authors), a totally different species. Schönbauer's paper is not common in the libraries, but the contents are detailed and there is an excellent figure. Authors would do well to consult Schönbauer's description, also the original description of *colombiachense* Fabricius, and Barnavot's paper of 1935 (see below), in which this last author proves that *colombiachense* Schönbauer and *reptans* Linnaeus are distinct species, before repeating the designation of *reptans* Linnaeus as the genotype of *Simulium*.

14 In connection with the early stages, it should be remembered that the eggs of only a few species are known; many pupae remain unknown and an even larger number of larvae are unknown or at least undescribed. An outline of the morphology, anatomy and biology of the *SIMULIDAE*, with particular reference to British species, has been given by Smart (1944).

15 Erroneously attributed to Hymenoptera by Sherborn (1923).
Latreille (1804: 180 and 1805: 291) stated that *colombaschensis* Fabricius was a synonym of *replans* L.; Meigen (1818: 289) stated that *colombaschensis* Fabricius was a synonym of his own new species *maculata* Meigen (1818), thus making it appear that he considered *colombaschensis* Schönbauer (if he knew of its existence), which he did not mention, a distinct species. Fabricius (1805: 56) followed Latreille and synonymised *colombaschensis* Fabricius with *replans* Linnaeus.

Consequent on Latreille’s statement, Latreille himself (1810: 442), Westwood (1840: 129), and Enderlein (1921) all gave *replans* Linnaeus as the genotype of *Simulium*.

*Rhagio colombaschensis* Fabricius and *C relu c colombaschensis* Schönbauer are considered as distinct species of *Simulium* in the catalogues of Kertész (1902: 286) and Becker et al. (1903: 156), the former as a synonym of *maculata* Meigen and the latter as a valid species: the cataloguers regard *replans* Linnaeus as distinct from both species. Most recent authors, including Enderlein (1930), regard *colombaschensis* Fabricius and *colombaschensis* Schönbauer as synonymous and distinct from *replans* Linnaeus. This view is followed in the present paper.

The identity of *Tipula regelalationis* L. is in doubt. If this is agreed to, then both *Atracocera* and *Melusina* are genera dubia. If the identity of *regelalationis* L. is not admitted to be dubious and the most usual application of the name accepted, then *Atracocera* and *Melusina*, according to the strict application of the rules of nomenclature, become synonymous with *Trichocera* Meigen (1803) (and *Petaurista* Meigen (1800) proc. *Petaurista* Link (1795)) and cease to be synonyms of *Simulium*.

Meigen (1818: 290) stated that his “*Tip. regelalationis*” (he omitted authors’ names at this date) of 1803 and 1804 was misidentified and that it was in fact the species to which he gave the name *ornata* in 1818. If *ornata* be accepted as the genotype of *Atracocera* and *Melusina*, then both become synonymous with *Simulium*. *Atracocera* is later than *Melusina* or *Simulium* and so sinks. *Melusina* has priority over *Simulium*.16 There are, however, a very large number of authors who refuse to use any of the generic names that Meigen proposed in his publication of 1800.17

While there are the doubts noted above about the application of the name *Melusina* Meigen (1800) there is none about *Simulium* Latreille (1802). Consequently the latter is used in this paper with *Melusina* Meigen of certain authors as a synonym.

Due, apparently, to miscomprehension of practice resulting from the application of the rules of nomenclature Baranov (1935), after he had proved that *colombaschense* Schönb. and *replans* L. were distinct species, proceeded to erect the genus *Danubiosinulium* with the former species as genotype, considering *replans* L. as the genotype of *Simulium*. Being thus isogenotypic with *Simulium*, the later genus, *Danubiosinulium*, falls at once as a synonym. The

16 If *ornata* Mg. be accepted as the genotype of *Melusina* and the name adopted as having priority over *Simulium*, then the family name becomes *Melusinidae*. Then if the generic proposals of Enderlein (1931, 1939, etc.) be adopted, *Melusina*, when used in a restricted sense, replaces Enderlein’s *Danaidae*, and *Simulium* reappears in the restricted sense in which Enderlein uses it. If *Melusina* be considered a genus dubium but *ornata* be considered the genotype of *Atracocera*, then this name and not *Melusina* becomes the equivalent of *Danaida* Enderlein.

17 Technically speaking, these authors may be said to regard all the generic names of Meigen 1800 as genera dubia. The nomenclatural side of the question cannot be gone into here. Stone (1914b), Collin (1942), *International Commission on Zoological Nomenclature, Opinion 152*, and Smart (1944a), are the most recent references on the topic of these 1800-names.
name was first proposed in a sub-generic sense but later Baranov (1938) gave it
generic status.

*Simulidium* Westwood and *Pseudosimulium* Handlirsch are fossil genera
(see further at page 475).

(3) *Sub-Family* **Parasimuliinae.**

The characteristics of the sub-family may be summarised as follows:

**Simuliidae** with sub-costs, radius and the two branches of forked radial sector \((R_2)\) well separated; \(R_4\) joins costa about middle of latter's length; and posterior branch of
forked \(R_3\) joins costa some distance before termination of the latter towards wing-tip. Macrotrichia on anterior wing veins all hair-like, longer than in *Simuliinae*; macrotrichia on upperside of both branches of \(R_2\). Sub-median fold unforked (apparently). Males dichoptic, with genitalia more exposed and rather more terminal in position than in other
*Simuliidae*.

Sub-family contains but one genus, *Parasimulium* Malloch from North America, of which female and early stages are unknown.

(4) *Genus* *Parasimulium.*


Genotype: *Parasimulium furcatum* Malloch by original designation of Malloch (loc. cit.).


*Parasimulium* Malloch of other authors.

The characteristics of *Parasimulium* may be summarised as follows:

*Parasimulium* with (in male at any rate) no basal cell, and \(Cu_2\) nearly straight.
Antennae 10-segmented (there is some doubt whether the number is 10 or 11 vide Stone
(1941a)); head more elongate in vertical axis than usual in *Simuliidae*, face narrow, frons
broad, eyes reniform, tending to approach mid-line beneath antennae. No caleipala or
pedisulcus. Tergites and sternites of abdomen fully chitinised and developed. External
genitalia, according to Stone (1941a) small, rather more terminal and exposed than in other
*Simuliidae*; if normal in unique type specimen of *furcatum*, they present considerable
differences in structure from those of species in other genera. Size, small, *furcatum* only
1-23 mm. in length.

Female and early stages unknown.

Unique specimen of *Parasimulium furcatum* Malloch taken in California; now in the U.S. National Museum at Washington.

Malloch (1914) mistook the sex of the unique specimen that is the genotype. Comparing his specimen with females of *Prosimulium* he differentiated the genus as follows:

"This genus differs in the female from *Prosimulium* Boubaud in having the eyes much
more widely separated at vertex, in having the frons much higher than highest level of eyes
when viewed from side, in having the face linear, in having the eye facets gradually enlarged
as they descend, and in the absence of the closed cell in the wing."

The discovery that the unique specimen was, in fact, a male, only demarcates
the genus more clearly than ever from other genera of the family.

The mistake in sex was pointed out by Knab (1914d : 180); Dyar & Shannon
(1927), who must have seen the genotype, omit any reference to its sex. Stone
*TRANS. B. ENT. SOC. LOND.* 95. PART 8. (DEC. 1945.)
Dr. John Smart on the classification

(1941a) re-examined the unique genotypic specimen and confirmed that it was a male; the condition of the specimen was very poor (vide Stone (1941a); also seen by the present author in 1933). The specimen is now remounted (by Stone) in balsam on a slide, a process that clarifies certain structures but tends to obscure the wing venation. Full elucidation of the status of the genus must await capture of further specimens of furcatum and its early stages, or the discovery of related species. The possibility that the unique type specimen of furcatum may be an abnormal specimen of some other species (possibly a male suffering from parasitic castration) should, perhaps, not be overlooked.

(5) Sub-Family Simuliinae.

The characteristics of the sub-family may be summarised as follows:

Simulidae with sub-costae, radius and radial-sector (R1) all close together; R1 joining costa well beyond middle of latter's length; R, simple or forked, the vein, if simple, or posterior branch thereof, if forked, joining costa practically at termination of latter towards wing tip; if forked the two branches of R, differ in vestiture of macrotrichia. Macrotrichia of anterior wing veins bristle-like and shorter than those found in Para-Simuliinae, with or without admixture of shorter spiniform macrotrichia. Sub-median fold forked. Males holoptic (except in two or three species); external genitalia rather more ventral in position and less exposed than in Para-Simuliinae.

The characteristics of the pupa, larva and egg are those given for the family Simulidae at page 476.

The sub-family contains five genera, Prosimitum, Gigantodax, Cnephia, Austrosimulium, and Simulium (restricted). As a group the sub-family is of cosmopolitan distribution. Some 800 forms have been described.

As now defined the sub-family Simuliinae is equivalent to the genus Simulium of all authors up to the time when Sureouf and Gonzalez-Rincones (1911) split that genus by giving generic status to the sub-genera proposed by Roubaud in 1906; it is the equivalent of the generic Simulium (sensu lato) of many authors subsequent to Sureouf and Gonzalez-Rincones (1911). It is the equivalent of the genus Simulium of Edwards (1931 and 1934); of the genera Prosimitum plus Simulium of Malloch (1914); of Prosimitum, plus Austrosimulium, plus Simulium of Dyar & Shannon (1927); of Prosimitum, plus Austrosimulium, plus Gigantodax, plus Simulium of Rubtzov (1940). It is not the same as Enderlein's (1930 et seq.) sub-family Simuliinae, which is a more restricted group.

(6) Genus Prosimitum.

Genotype: Simulium hirtipes Fries by original designation of Roubaud (loc. cit.).


Genotype: Simulium fereginum Wahlberg by original designation of Enderlein (loc. cit.).

Genotype: Simulium macrospye Lundstrom by original designation of Enderlein (loc. cit.).

The characteristics of Prosimitum may be summarised as follows:

Simuliinae with radial-sector forked. Macrotrichia of anterior wing veins all bristle-like (no spiniform ones present). Anterior branch of radial sector (R1) a concave vein,
of the Simuliidae (Diptera).

bare above; posterior branch a convex vein with triple row of macrotrichia above. Basal section of radius with macrotrichia on upperside; basal cell present; Cu, sinuous. No calcipala, no pedisulcus. Antennae 11-segmented except in one species, novum Dyar & Shannon, in which they are 9-segmented.

Known pupae, with one exception, all with many branched somewhat dendroid respiratory organs; terminal spines 18 present. Cocoons somewhat roughly spun, lacking definite shape usually associated with pupae of Simuliidae; with weak area through which the adult pushes its way after eclosion and not the usual clearly defined opening. In one species, ferrugineum Wahlberg, the respiratory organs, according to Puri (1926) and Rubtsov (1940), somewhat resemble those of Austrosimulium.

Known larvae with simple anal gills; no ventral papillae; the mental plate armed with a median trifid tooth and, on either side thereof, three bifid teeth all of about same density of chitinisation and length as median trifid tooth.

Eggs and oviposition habits unknown. The fact that they elude discovery would indicate that oviposition is not the same as that usually associated with Simuliidae.

Prosimulium is Holartic in distribution and within this region species seem addicted to the very rapid streams of mountainous regions which in spring are filled with a great volume of cold water originating in melting snows. Species appear to be univoltine. Females of some species vicious biters.

Roubaud's Pro-Simulium, a sub-genus, was principally characterised by the possession of hind second tarsal segments which were somewhat elongate, parallel-sided and without a pedisulcus or as he said "sans échancrure basilaire." This meant that species now included in Cnephia were included. It is rather extraordinary that Roubaud failed to notice the forked condition of the radial-sector in some of his species. He noted that some species included had no calcipala while others had a small one.

Sercouf & Gonzalez-Rincones chose as their principal characteristic for Prosimulium, which they regarded as a genus, the complete absence of the calcipala with the absence of the pedisulcus as a supporting character. This made their segregate a much more homogeneous one than Roubaud's; in fact it corresponds exactly to the genus as defined in this paper except that it seems better to use the characteristics of the wing venation rather than the less easily appreciated tarsal characteristics as the principal feature of the genus. Unfortunately the work of these two authors was subsequently discounted owing to certain features of the treatment they gave to the species they were dealing with. The credit for the elevation of Roubaud's Pro-Simulium to generic rank is usually given to Malloch (1914), whereas it rightly belongs to Sercouf & Gonzalez-Rincones (1911).

Malloch defined Prosimulium as without a pedisulcus, without or with very small calcipala, with the radial-sector generally forked and with a basal cell. This definition meant that his segregate was exactly the same as Roubaud's and that it included species, pecuarum Riley, mutatum Malloch and borealis Malloch, now assigned to Cnephia.

Dyar & Shannon realised the importance of the features of the wing venation in the classification of the Simuliidae. They defined Prosimulium as with forked radial-sector, basal section of radius with macrotrichia above, lacking

18 There are numerous small chitinous spines and hooks on the abdominal tergites of Simulid pupae; "terminal spines" are two exceptionally large ones, pointing anteriorly, on last abdominal segment.

19 "Ventral papillae" are conical, downward directed papillae found, one on either side of hind end of body, in some species of Simuliidae.
both calcipala and pedisulcus, tarsi slender and the front in female relatively broad. This definition threw out of the genus species belonging to Cnephia, which Roubaud's and Malloch's definitions had included, and makes the segregate correspond to that of the present paper.

Enderlein (1921a, c and 1930) defined his sub-family Prosimulinae on broader lines than Dyar & Shannon had defined their genus Prosimulium. Enderlein (1921a, c) retained both pecurium Riley and mutatum Malloch in Prosimulinae, but he took the former out of Prosimulium and made it genotype of a new genus Cnephia of which (as restricted by Enderlein, not as used by Edwards or as used in the present paper) it remained the only species; mutatum Malloch remained in Enderlein's Prosimulium till he (1930) removed it to the new genus Mallochella of his sub-family Stegopterinae. Enderlein's genus Prosimulium is a more restricted group than the genus of the present paper.

Enderlein (1921a) described the genus Helodon by differentiating it in a key to genera and naming the genotype. The couplet of the key which separates Helodon from Prosimulium reads as follows:

Klauen beim ♀ mit auffallig langem Zahn; beim ♂ viel kürzer

Helodon Enderl. 1921.

Klauen auch beim ♀ einfach, Hinterbeine des ♂ mit sehr langer Behaarung

Prosimulium Roub. 1916.20

Enderlein does not seem to have published any amplified diagnosis of the genus. Apart from the genotype, ferrugineus Wahlberg, only one other species, Prosimulium pecurii Malloch, has been assigned to Helodon by Enderlein. Both these species are typical Prosimulium as that genus is considered in the present paper and, following Dyar & Shannon (1927) and Edwards (1931), Helodon is regarded as a synonym of Prosimulium, the characters on which Enderlein differentiated it being considered insufficient to justify the use of two generic segregates.

Taeniopterna Enderlein (1925), a genus to which Enderlein has assigned no other species than the genotype, Simulium macropyya Lundström, is differentiated from Prosimulium by the fact that in macropyya the hind basitarsus of the male is parallel-sided while in the species assigned to Prosimulium by Enderlein the male hind-basitarsus is "spindle-shaped, even if sometimes only very slightly so." To use such criteria for the separation of segregates which are to be given generic status is ridiculous and Taeniopterna is therefore treated as a synonym of Prosimulium following Edwards (1931); Dyar & Shannon (1927) do not mention Taeniopterna.

Edwards (1931), while lowering the taxonomic status of Prosimulium to that of a sub-genus, adhered to the definition of the segregate applied by Dyar & Shannon (1927), but he pointed out that the trichiation of the anterior wing veins consisted solely of bristle-like macrotrichia (i.e. no spiniform ones present) and that the anterior branch of the forked radial-sector was naked on the upper-side, being a concave vein. He also emphasised the importance of the presence of a basal cell in the wing field. He synonymised Helodon Enderlein and Taeniopterna Enderlein with Prosimulium, but separated Cnephia Enderlein and Mallochella Enderlein from Prosimulium. Edwards' sub-genus Prosimulium was thus a smaller segregate than Enderlein's sub-family Prosimulinae but larger than that author's genus Prosimulium. It is the genus of the present paper.

20 Sic; error for 1906 given correctly in (1921c).
(7) Genus Cnephia.

Genotype: *Simulium pecuarum* Riley by original designation of Enderlein (loc. cit.).

Genotype: *Hellichia latifrons* Enderlein by original designation of Enderlein (loc. cit.).

Genotype: *Simulium pecuarum* Riley by original designation of Enderlein (loc. cit.).

Genotype: *Ectemnia teniatifrons* Enderlein by original designation of Enderlein (loc. cit.).

Genotype: *Mallochella sibirica* Enderlein by original designation of Enderlein (loc. cit.).

*Preoe.* MallocheUa Duda, 1925 (Borboridæ).
Genotype: *Simulium (Cnephia) gynandra* Edwards by original designation of Enderlein (loc. cit.).


The characteristics of *Cnephia* may be summarised as follows:—

**Simulinae** with radial-sector (R. unbranched but, sometimes, with tip swollen where it joins costa; basal section of radius with macrotrichia on upperside: distally R. a convex vein, with single row of hairs on upperside. Basal cell present; Cu. sinuous: spiniform macrotrichia intermixed with bristle-like ones on costa. Antennae 11-segmented. Female claws toothed or untoothed. Calcipala minute or absent; pedisulcus absent or represented by a vague constriction (see, however, notes on *Ectemnia* below).

Known pupae with branching dendroid respiratory organs each with 12-50 ultimate branches much as in *Prosimulium*. Cocoons of some species irregular as in *Prosimulium*, in others of the simple slipper-shape usually associated with *Simulinae* but rather loosely woven and without a definitive rim to the opening. No terminal spines on abdomen.

Known larvae not remarkable. The anal gills simple; ventral papillae absent.

Egg of one species, *Cnephia pecuarum* (Riley), known: Bradley (1935a & b) states that it has a reticulate surface and is laid singly or in small groups, not in the usual large agglutinated masses.

Genus recorded from Holarctic, Neotropical and Australian regions, but absent from Oriental and Ethiopian regions.

Enderlein (1921) seized upon the non-furcated but swollen tipped condition of the radial-sector in *pecuarum* Riley to erect the genus *Cnephia*, in his subfamily *Prosimulinae*, for this species. *Mallochella* was erected by Enderlein (1930) for a new species, *sibirica* Enderlein, and *mutatum* Malloch, which Enderlein discovered to possess a pedisulcus in the form of a slight constriction of the second hind tarsal segment. Malloch (1914) had noted the existence of this constriction but Enderlein (1921a & c) left *mutatum* Malloch in *Prosimulium*. Possessing a pedisulcus *Mallochella* was placed by Enderlein (1930) in the *Stegopterinae*, not in the *Prosimulinae*.

Edwards (1931) indicated that he believed Enderlein (1930) to be in error in ascribing the possession of a pedisulcus and complete lack of calcipala to his species *teniatifrons*, which he made genotype of *Ectemnia*, and he stated further that if the possession of a pedisulcus and the complete lack of a calcipala be ignored, the description of *teniatifrons* Enderlein applies to *pecuarum* Riley; the two species are sympatric. It is perhaps worth noting that when *teniatifrons* was first described by Enderlein (1925 : 206) he placed it in *Cnephia*, not
at that time considering it worthy of further generic segregation (according to Enderlein (1930) _Cnetha_ has a calcipala). Following Edwards (1931) _Ectemnia_ is here regarded as a synonym of _Cnephia_ but the other genera of Enderlein's sub-family _Ectemniinae_ are regarded as synonyms of _Simulium_ (see further below at page 493).

_Hellichia_ and _Astega_ are the only genera comprising the sub-family _Hellichiinae_ of Enderlein (1930) (= tribe Hellichini of sub-family _Prosimulinae_ of Enderlein (1925)). The two genera differ from each other, it seems, only in the toothed and untoothed condition of the female claws and in the shape of the hind basitarsus of both sexes. The simple radial-sector separates the _Hellichiinae_ from the _Prosimulinae_ of Enderlein, but they are alike in the complete absence of either calcipala or pedisulcus; the lack of both calcipala and pedisulcus differentiates Enderlein's _Hellichiinae_ from his _Ectemniinae_, _Nevermanninae_ and _Simulinae_. _Hellichia_ and _Astega_ must be regarded as synonyms of _Cnephia_.

_Steopterna_, along with _Mallochella_ and _Gigantodax_, constitute the Enderleinian sub-family _Steopterninae_. These have a simple radial-sector, a calcipala but no pedisulcus and are thus differentiated, by Enderlein, from his _Prosimulinae_ (with forked radial-sector), from his _Hellichiinae_ and _Ectemniinae_ (without calcipala but with pedisulcus) and from his _Nevermanninae_ and _Simulinae_ (with both calcipala and pedisulcus). As was the case with _Hellichia_ and _Astega_, _Mallochella_ and _Steopterna_ are differentiated from each other mainly on the toothed and untoothed condition of the female claws and in the shape of the hind basitarsus of both sexes. Following Edwards (1931), these two genera are regarded as synonyms of _Cnephia_ from which, as the latter is now defined, they differ solely in possessing larger calcipala than the other segregates that have been suggested amongst species now placed in this genus.

_Simulium_ (Cnephia) _gynandra_ Edwards, the genotype of _Cnesia_ Enderlein, was described from a series of specimens which Edwards (1931) took to be gynandromorphs. Enderlein, believing that this series contained males with dichoptic eyes, immediately erected the genus _Cnesia_ for the species on account of this character. The matter has been commented on at page 468. The genus cannot be admitted to be valid.

Edwards (1931) redefined the group (Cnephia) with sub-generic status, in such a way that all the genera discussed above, except the more recent _Cnesia_, fell as synonyms. The limits of his sub-genus are those of the present genus.

Some species assigned to _Eusimulium_ by authors are in fact species of _Cnephia_ as defined in the present paper. Unfortunately the nomenclatural status of _Eusimulium_ is ambiguous and has been interpreted differently by authors. The genotype of _Eusimulium_ is not a species of _Cnephia_ but since _Eusimulium_ of authors appears in the synonymy of _Cnephia_ given above it will be convenient to deal with the various questions connected with the name at this point.

Writing before the rules of nomenclature were promulgated in the form now familiar, Roubaud (1906) used the expression "nous détacherons donc de l'ancien genre unique _Simulium_ Latreille deux sous-genres nouveaux," _Prosimulium_ and _Eu-Simulium_. This can be interpreted to mean that _Prosimulium_ and _Eu-Simulium_ are cut out of _Simulium_ (sensu lato et antiquo),

21 The two genera placed by Enderlein in _Ectemniinae_ in 1930, _Ectemnia_ and _Pteranaspatha_, were differentiated from each other on these selfsame features! _Gigantodax_ was redefined by Edwards (1931); it is dealt with below at page 486.
leaving a residue to which the name *Simulium* could be applied in a sub-generic sense. *S. aureum* Fries is the only specific name associated with *Eu-Simulium* in 1906 and so it is possible to regard this species as the genotype of *Eusimulium*, leaving *Simulium* as a separate segregate with *colombaschensis* Fabr. (or *novanLinnaeus*) as the genotype. This is the view adopted by Dyar & Shannon (1927), whose interpretation of *Eusimulium* is usually followed; it was also the view taken by Surcouf & Gonzalez-Rincones (1911) (see below). Earlier, Roubaud (1905) had hinted at the division but he did not make it and give names to the segregates till 1906.

On the other hand, it can be maintained that Roubaud (1906) did not cut *Pro-Simulium* and *Eu-Simulium* out of *Simulium* (*sensu lato*, etc.), leaving an undefined *Simulium* (restricted) but that he divided *Simulium* (*sensu lato*, etc.) into *Pro-Simulium* and *Eu-Simulium* and that he made a mistake in naming his second segregate *Eu-Simulium*, it being in effect *Simulium* (restricted): this means that *Eu-Simulium* Roubaud (1906) is a still-born synonym of *Simulium* (restricted). If this is the case, then the genotype of *Simulium* is the genotype of *Eusimulium* and any other designation is erroneous. This is the view taken by Enderlein (1925 and 1936b) and it is also the view implied by Malloch (1914): this view has not been generally followed, though it receives support from the fact that later Roubaud (1909) included *colombaschensis* Fabr., the genotype of *Simulium*, in *Eusimulium*, along with several other common European species, an act that seems to indicate that he did not consider that the detachment of *Pro-Simulium* and *Eu-Simulium* from *Simulium* (*sensu lato*, etc.) left any residue.

The first interpretation is the one usually accepted and *Eusimulium* is considered in the light of Dyar & Shannon's (1927) interpretation of the genus in spite of the fact that this post-dates Surcouf & Gonzalez-Rincones's (1911) interpretation.

If the second interpretation is accepted, then *Eu-Simulium* Roubaud (1906) sinks as a synonym of *Simulium* Latreille (1802) and a generic name *Eusimulium* (attributed to Roubaud) of Dyar & Shannon (1927) and of Surcouf & Gonzalez-Rincones (1911) and other authors following them is left, which is in fact a homonym of *Eu-Simulium* Roubaud (1906) and a new name would be required for the segregate if it were to be maintained.

In 1921 Enderlein included *S. aureum* Fries in *Nevermannia* Enderlein (1921a) (*genotype: annulipes* Becker (1908)), later (1921c) he erroneously gave *aureum* as the genotype of *Nevermannia*, but in 1922 he (1922: 69) transferred *aureum* to *Cnetha* Enderlein (1921) (*genotype: latipes* Meigen (1904)).

If *latipes* Meigen, *annulipes* Becker and *aureum* Fries are considered congeneric then, since *Nevermannia* has page priority over *Cnetha*, the former name is available to replace *Eusimulium* Roubaud of authors; if, however, *aureum* Fries and *annulipes* Becker be considered congeneric but *latipes* Meigen be considered as belonging to a different generic segregate, then *Cnetha* is available. Should it ever become desirable to split Enderlein's *Cnetha*, with *aureum* in the segregate to be split off (*annulipes* Becker would, of course, have to remain in *Cnetha*, however much that segregate was restricted), then *Eusimulium* could be revived for this segregate. This would, however, be very undesirable and if the generic synonymy now proposed is accepted no substitute name for *Eusimulium* is required since *Eusimulium* of authors sinks as a synonym in part to *Cnethia* and in part to *Simulium* (restricted).

In the present paper Dyar & Shannon's (1927) application of *Eusimulium* Roubaud is accepted for purposes of discussion.
(8) Genus Austrosimulium.


Genotype: _Simulium austrosimulium_ Schiner by original designation of Tonnoir (loc. cit.).

_Austrosimulium_ Tonnoir of Edwards, 1931, _Dipt. Pat. S. Chile_ 2 (4) : 142.

_Austrosimulium_ Tonnoir of other authors.

The characteristics of _Austrosimulium_ may be summarised as follows:—

_Simulium_ with 10-segmented antennae and the basal section of the radius with macrotrichia on its upper surface. Radial-sector (R,) simple, unbranched and a single row of macrotrichia on upperside of its convex distal section; spiniform macrotrichia intermixed with bristle-like ones on costa; Cu, sinus; basal cell present but poorly developed. Calicípala and pedisulcus present; female claws with or without basal tooth.

Known pupae with respiratory organs conforming to one basic pattern, namely a stout column from which arise numerous rather fine filaments; terminal spines not recorded as present. Cocoons with definite shape and opening.

Known larvae with ventral papillae, anal gills simple, unbranched. According to Edwards (1931 : 129), anal selerite completely surrounds anus.

Genus appears to be confined to temperate Australia, Tasmania, New Zealand and Andean South America. Nothing known of early stages of Chilean species.

Tonnoir (1925) erected _Austrosimulium_ for the reception of certain species of the Australian, Tasmanian and New Zealand faunas. This segregate has been accepted by Edwards (see page 471) but ignored by Enderlein (see page 467). Tonnoir found the Enderleinian classification unacceptable. The principal feature upon which Tonnoir founded the genus was the 10-segmented antennae, which remains the most distinctive character though it would appear that species with 9-segmented antennae occur.23

Tonnoir states (1925) that his species of _Austrosimulium_ would run to Enderlein's _Cnetha, Mevermannia_ and _Wilhelmia_ which, however, all possess 11-segmented antennae; Tonnoir does not accept Enderlein's classification.

Edwards (1931) redefined the segregate with sub-generic status; his sub-genus has the same limits as the present genus.

(9) Genus Gigantodax.


Genotype: _Gigantodax bidens_ Enderlein by original designation of Enderlein (loc. cit.).


_Archiodesia_ Enderlein, 1934, _Dipt. Pat. S. Chile_ 2 (4) : 273.

Genotype: _Simulium (Gigantodax) feminum_ Edwards by original designation of Enderlein (loc. cit.).

The characteristics of _Gigantodax_ may be summarised as follows:—

_Simulium_ with radial-sector (R,) simple, unbranched, a convex vein, somewhat sinuous with a single row of macrotrichia on upperside distally; basal section of radius with macrotrichia on upperside. Macrotrichia of costa both bristle-like and spiniform; Cu,

23 The "anal selerite" is an X-shaped sclerotisation of the integument posterior to anus and between it and the "posterior sucker." The upper arms of the X contain the anus, and in _Austrosimulium_ and _Gigantodax_ form the ring alluded to above. Lower arms run for a short distance along the upper edge of the ring of radial rows of hooks that form the "posterior sucker."

24 _Austrosimulium bentacrafti_ (Taylor) was described as having the antennae 9-segmented. Tonnoir (1925 : 242) asserted that the antennae of this species were in fact 10-segmented. Taylor (1927 : 70) and Drummond (1933 : 5) dispute this assertion of Tonnoir's.
straight; Ant also straight, terminating rather farther from end of Cu, than in other genera; no basal cell. Coxae rather less hairy than in other genera; hind basitarsus narrow, parallel-sided and exceptionally long, equalling tibia in length and exceeding length of remaining tarsal segments taken together. Pedisulens absent; calcipala present, exceptionally long and wide. Female claws with strong basal tooth. The exceptional species, *feminea* Edw., with the compound eyes of the male dichoptic, belongs to this genus.

Known pupae possess respiratory organs each with 8 filaments arranged in a dorsal group of 8 and a ventral group of 10, both groups springing from short common stalk. Terminal spines present.

Known larvae with the chitinous anal selerite forming complete ring round anus. Anal gills simple. Ventral papillae absent.

(Simulium is found in Andean South America and has recently been recorded by Vargas (1941) from Mexico.

Enderlein (1925), in his diagnosis of *Gigantodax*, appreciated the importance of the exceptionally long hind basitarsus and the strongly sinuous radial-sector as characteristics of generic value; Edwards (1931), working with a co-type of the genotypic species before him, drew attention to the other characters which have already been discussed at page 471. It may be noted that Enderlein (1933) described a new species of *Gigantodax* but made no comment on Edwards' redefinition of the genus though there is ample evidence (the genotype of *Archimelia*, etc.) that he had Edwards' paper of 1931 before him at the time.

*Simulium* (*Gigantodax*) *feminea* Edwards, the genotype of *Archimelia*, is remarkable, the males having dichoptic eyes and no differentiation of the size of the upper eye-facets. Enderlein seized upon this and erected the genus for this species alone; he has not indicated any characters whereby females can be differentiated from those of species of *Gigantodax*. The matter has been commented on at page 468. The genus cannot be admitted to be valid.

The status of *Eusimulium* has been dealt with at page 484.

(10) Genus *Simulium* (*restricted*).


Genotype: *Rhagio colomboschneideri* Fabricius by original designation of Latreille (loc. cit.) (in part; see further at page 477).

*Melania* Meigen, 1800 (see at page 476; in part).

*Altarces* Meigen, 1803 (in part; see further at page 478).

*Simulium* Latreille of authors (in part).


Genotype: *Simulium arenosum* Fries by original designation of Roubaud (loc. cit.).


*Exsimulium* Roubaud of authors (in part).

*Simulium* (sub-genus) of Edwards, 1934, *Arch. f. Hydrobiol., Suppl.-Hdb.*, 13, "Tropische Einwage-


Genotype: *Simulium talipes* Meigen by original designation of Enderlein (loc. cit.).


Genotype: *Simulium arenipes* Meigen by original designation of Enderlein (loc. cit.).


Genotype: *Schönaueria matthisenii* Enderlein by original designation of Enderlein (loc. cit.).

21 Enderlein (1921c: 44) erroneously stated that *S. anna* Fries was the type of *Neccrannia*. He (1922: 69), in a paper in which he quoted *S. arenipes* Becker as type of *Neccrannia*, stated that *anna* belonged to *Cochta* (see also at page 485).

22 From the point of view of those interested in the niceties of nomenclatural technique, the position of three of Enderlein's genera should be stated. They are *Schönbaueria*, *Chrostelina* and *Gomphostelina*.

These three genera were erected (1921a) in a dichotomous key in a publication of 16th
April 1921. The genera each contained but one species, the genotype, but these species had not been described.

In a publication (1921b) dated 1st June Schönhaueria gen. n. and S. matthiessenii sp. n. were described, the species being the genotype and the only included species of the genus.

In a publication (1921c) the matter of the first publication was reprinted, the date being 7th June 1921.

In a publication (1921d) dated 20th December 1921 a description of "Gomphostilbia Enderl. 1921" was given along with that of C. eugoniensis sp. n., which was stated to be the genotype and the only included species. In this same paper "Chironelliin Enderl. 1921" was described along with the genotype C. floriferum sp. n.

Taking a very extreme point of view in one direction, it is possible to say that these three genera of 1921 were all genera dubia, since the genotypes were undescribed. It therefore follows that the names when later published with description of the genotypic species were still-born homonyms and thus require renaming.

On the other hand, since these three genera are monotypic, at the time they were described in the dichotomous key, it is possible to maintain that the species that are the genotypes could be recognised from the key. Since the later publications make the application of the key perfectly clear it is obviously best to adopt this latter point of view. To adopt the former would merely mean finding three more names to burden the synonymy, without helping to clarify anything at all.

In this paper the genera are regarded as valid with their genotypes from 16th April 1921 and the subsequent descriptions are regarded as amplifying the original ones in spite of the species being labelled "nov. spec." and Schönhauereia a "nov. gen." in the later publications.
of the Simulidae (Diptera).

Genotype : *Acronegus barbatipes* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Ethnomedina nasseri* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Palsaphilus rufilorum* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Thyrsopelma bezzianum* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Trichodagmium latitarsis* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Humicnema mexicana* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Psaronicosps opalinifrons* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Simulium kandleri* Malloch by original designation of Enderlein (loc. cit.).

Genotype : *Psilopelmia scapulata* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Thymophora maculata* Meigen by original designation of Enderlein (loc. cit.).

Genotype : *Metophalus coffier* Enderlein by original designation of Enderlein (loc. cit.).

*Philodina* Enderlein by original designation of Baranov (loc. cit.) (see page 478).

Genotype : *Chitosimulium (Chitosimulium) cupiculum* Seguy & Dorier by original designation of Seguy & Dorier (loc. cit.).

Genotype : *Palloria graminicola* Malloch by original designation of Enderlein (loc. cit.).

Genotype : *Cryptopenera breviterga* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Chelonechta hirvi* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Psilophorcher oculata* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Philodina guttata* Enderlein by original designation of Enderlein (loc. cit.).

Genotype : *Philodina guttata* Enderlein by original designation of Baranov (loc. cit.).

*Extrachironomida Baranov, 1938, V et. Artic. 8: 313.
Genotype : *Extrachironomida echinatum* Baranov by original designation of Baranov (loc. cit.).

Genotype : *Simulium decumatum* Dorogostajskij, Rubtsov and Vlasenko by designation of Rubtsov (1940).

Genotype : *Simulium conchaves* Hearle by designation of Rubtsov (loc. cit.).

Genotype : *Simulium vittatum* Hearle by designation of Rubtsov (loc. cit.).

The very imperfectly known fossil genera *Simulium* Westwood and *Pseudosimulium* Handlirsch have been considered as synonyms of *Simulium sensu lato et antiquo* (see page 477).

The characteristics of *Simulium* may be summarised as follows:

**Simulinae** with simple, unbranched radial-sector (R.); no basal cell; Cu₂ simous; macrotetra of costa bristle-like intermixed with spiniform. In all but a few species both cedipala and pedisulcus present. Basal section of radius naked or with macrotetria on upperside; distal section of radius with or without macrotetria on upperside. Antennae 11-segmented except in very few species. Claws with or without teeth.

Known pupae possess respiratory organs of various shapes, some coarse, relatively thin-
walled finger- or horn-like structures; others the usual narrow filamentous tubes with relatively thick walls; branched to some extent but never of multiple-branched dendroid type associated with Proximulium and Cnephia nor special types associated with Austro- 
simulium and Gignatofex: some African species with respiratory organ in the form of a 
finger-like column with a few thin branches on its surface. No terminal abdominal hooks. 
Cocoon always of definite shape with opening; shapes vary considerably from species to 
species and frequently highly characteristic. 

Known larvae not remarkable. Anal gills simple or branched. Ventral papillae 
present or absent. Some species have small papillae on body wall. 

Characteristics of eggs noted at page 477.

Genus cosmopolitan: the possibility of its being of polyphyletic origin has 
been mentioned at page 473.

As treated in the present paper Simulium (restricted) is the equivalent of 
Edwards' sub-genera Simulium (restricted), Morops and Euximulium of 1931 
or his Simulium (restricted as a sub-genus) of 1931. It is the equivalent of all 
the 13 genera assigned by Enderlein to his sub-family Simulinae, all the 20 
genera assigned by him to his sub-family Nevermanninae and four of the five 
genera assigned by him to his sub-family Ectemminae.

Edwards (1931) gave Euximulium Roubaud sub-generic status, but he 
admitted the difficulties in the way of maintaining it as a segregate distinct from 
Simulium, as he restricted the latter with sub-generic status. Eusimulium was 
maintained (mainly by authors dealing with the fauna of the new world) as a 
segregate, with generic status, on account of the macrotrichia on the upperside 
of the basal section of the radius in combination with a simple radial-sector, a 
definition that included species now assigned to Cnephia. This definition 
became useless when Puri (1932c) redescribed the oriental species, Simulium grisesceus Brunetti, and pointed out that in this species the females have the basal 
section of the radius clothed with macrotrichia above, while in the males it is 
naked. The point was clinched when Puri (1933a) described a gynandromorph 
of grisesceus in which the basal section of the radius was pilose on the one 
side of the creature and naked on the other. This happens in some other 
oriental species. Edwards (1934) ceased to distinguish between Eusimulium and 
Simulium even at the sub-generic status that he had accorded them in 
1931, though he continued, quite legitimately, to use the condition of the 
upperside of the basal section of the radius as a means of splitting the species of 
a limited fauna into two groups for identifying them with keys. The character 
remains useful for this purpose in spite of the depreciation of its generic value. 

Morops was treated as a sub-genus by Edwards (1931), but he indicated his 
dissatisfaction with the characterisation of the segregate. Edwards differen-
tiated Morops mainly by the fact that a species (vunicorne Edw.) which he 
thought akin to the genotype of Morops possessed 10-segmented antennae. 
Morops is described as having the hind tibia exceptionally swollen, a condition 
also found in the species that Edwards had before him. Edwards (1934) 
regarded Morops as a synonym of Simulium (restricted) at the same time as he 
ceased to distinguish Euximulium as a distinctive segregate (see above).

According to Enderlein, Ectemminae are distinguished from Never-
manninae and Simulinae by possession of a pedisculus and absence of a 
calcipala, while the latter two have both calcipala and pedisculus. If the lack 
of a calcipala be ignored, the sub-family Ectemminae would merge into the 
Nevermanninae of Enderlein. Edwards (1931 : 111) has given reasons why 
he considers Enderlein's lateridifrons, genotype of Ectennia, to be the same
species as *prevariacm* Riley, genotype of *Cnaphia*, and in the latter species there is a minute calcipala but the pedisulcus is very indistinctly developed. It would thus appear that complete lack of calcipala ascribed to the Enderleinian sub-family *Ectemniinae* may be a mistake and that the pedisulcus possessed by species in the sub-family may be but a weak one. *Pternaspatha* was erected for reception of a single species (see further on page 493). This species lacks a calcipala, but, as pointed out by Edwards (1931:154), it is obviously a close relative of three other sympatric species which possess a calcipala. Edwards (1931) therefore regarded *Pternaspatha* as a synonym of *Simulium* (restricted) as a sub-genus. Enderlein has assigned only five species to *Ectemniinae*, one to each of the five monotypic genera that constitute it! It would therefore appear that the segregation of the *Ectemniinae* from the *Nevermanninae* rests on somewhat uncertain ground and it is proposed to disregard it; the other individual genera, *Aspathia*, *Psilozoa* and *Cryptectemnia* are considered below.

The sub-families *Nevermanninae* and *Simulinae* of Enderlein are separable mainly on the fore-basitarsus being "normal" in the former and swollen and flattened in the vertical plane in the latter. This characteristic was used by Edwards (1915) to divide British species of the family into two groups "A" and "B". These groups correspond with *Eusimulium* and *Simulium* of Dyar & Shannon (1927) and authors following them, but the fore-basitarsal character was regarded as secondary to the presence or absence of hairs (macrotrichia) on the upperside of the basal section of the radius. It has already been pointed out that the trichiation of the basal section of the radius is not a satisfactory characteristic (see page 490) and Edwards, on various occasions prior to 1931, was at pains to point out that his division of *Simulium* (sensu lato) into groups "A" and "B" was for convenience in dealing with some restricted fauna and though he admitted *Eusimulium* to sub-generic rank in 1931 he discarded the proposed segregate in 1934. If the features of the fore-basitarsus could not be used to substantiate the identity of Edwards' two sub-genera (*Eusimulium* and *Simulium* as restricted at 1931), it seems highly undesirable to differentiate sub-families by means of them.

In 1921 the sub-family *Nevermanninae* of Enderlein, or as it was then the tribe *Nevermanniini* of the sub-family *Simulinae*, consisted of the genera *Nevermannia*, *Ctnella*, *Gomphostilbia*, *Wilhelmina*, *Schönfischeria* and *Stilbophorus*, while the *Simulinae*, or as it was then the tribe Simulini, consisted of *Simulium* (restricted), *Byphlitora*, *Oliaquina*, *Chrostilbia* and *Edwardshellock*. By 1930 *Friesia*, *Notoleptra*, *Morops* and *Anasolen* had been added to the former group, while *Discosphenia*, *Byssodon* and *Gymnocheilum* has been added to the latter. By 1937 a further ten new genera had been added to the former and five to the latter sub-family.

Enderlein chose the condition of the fore-basitarsus to separate the *Nevermanninae* from the *Simulinae* and in both these sub-families his first character for the discrimination of the included genera was the toothed or untoothed condition of the claws.27 Other characters used by Enderlein to differentiate the genera within both his *Nevermanninae* of 1921 and his *Simulinae* of 1921 were the condition of the male hind tarsi (including the basitarsus), the size of

---

27 One hesitates to suggest that Dr. Enderlein's classification would have been just as useful—and elaborate—if he had used the toothed and untoothed condition of the female claws to segregate his two sub-families and then used the normal or swollen condition of the fore-basitarsus for the initial segregation of the contained genera! It is interesting to recall here the use Enderlein made of the trichiation of the basal section of the radius to differentiate genera within both the sub-families (see page 469)!
the abdominal tergites, the condition of the hind-basitarsus of the female, the position of the tooth on the female claw when present and the type of scales on the abdomen.

That the species grouped into two sub-families should be susceptible to generic segregation within these sub-families when tested with more or less the same set of criteria is indeed remarkable, if it is not a clear indication that the sub-families themselves are completely artificial creations of Enderlein’s mind.

By 1930 the following criteria had been added to enable NEVERMANNINAE to be split up into its now eleven constituent genera: length of the last tarsal segment of the female leg and the proportion of this to the length of the claw, the vestiture of the dorsum of the thorax, the coloration of the dorsum of the thorax, the shape of the hind tibiae of the male, and size of the upper eye-facets of the male. The new criteria applied to the SIMULINAE, now, in 1930, consisting of eight genera, were: the coloration of the dorsum of the thorax, and the size of the upper eye-facets of the male. Once again the similarity of the criteria applied to both sub-families is striking.28

The view that it is proposed to adopt in the present paper is that Enderlein’s initial division of NEVERMANNINAE and SIMULINAE (in the Enderleinian sense of 1930) is unsatisfactory and cannot be upheld; that the characterisation of the genera within both sub-families is weak and unjustified; further, that the very method of segregating the two sub-families and then the genera within them is such as to suggest that the whole edifice of sub-families and their genera is extremely artificial, and therefore cannot be admitted as a satisfactory classification. Since both the sub-families are within the segregate regarded as the genus Simulium in the present paper, all the genera placed within them by Enderlein fall as synonyms.

The Enderleinian genera of the NEVERMANNINAE and SIMULINAE created up to and including 1930 have been dealt with above: they were also considered by Edwards in 1931. 1930 was: the date of the last synoptic paper on the classification of the SIMULIDAE by Enderlein; since that date a total of fifteen new genera have been added to these two Enderleinian sub-families: these must now be considered.

Enderlein (1934a) stated that the basal section of the radius was naked in Friesia and erected Dasypelmoza for the reception of species, previously in Friesia, in which the basal section of the radius bore macrotrichia on its upper side. At the same time Thysopolma, with the basal section of the radius bearing macrotrichia above, was split off from Simulium (as restricted by Enderlein) in which the basal section was now defined as naked; Trichodagmia was differentiated from Oskymia in the same way. It will be noted that the first pair of genera belong to Enderlein’s NEVERMANNINAE, while the latter two pairs belong to his SIMULINAE.

Aeropogon is stated by Enderlein (1934a) to be near Friesia, but the fore and hind legs of the former have the femur and tibia clothed with long hairs, while in the latter the vestiture is short; the male of the former has hairs between the eyes and the tooth of the claws but slightly developed, in the latter there are no such hairs and there are well-developed teeth of the claws. Ectennaspis is near Wilhelmina, but the former has short untoothed claws in the female, while in the latter genus they are toothed and exceptionally long; although the male of one species of Ectennaspis is known, no generic characters for that sex have been

28 It is perhaps as well, at this point, to remember that Enderlein exhausted the potentialities of the characteristics of the calcipala and the pedisuleus in his initial division of the SIMULIDAE into six sub-families that he recognised in 1930!
of the Simuliiidae (Diptera).

493

mentioned by Enderlein. *Psilopelmia* is differentiated from *Morops* by the metasternum of the male of the former being twice as broad as long, while in the latter it is four times as broad as long. The upper eye-facets of the former are not developed to the same size as in the latter genus. All these genera belong to Enderlein's *Nevermanninae*.

According to Enderlein (1934b), *Hemicnetha* is differentiated from *Cnetha* by the sub-costal section of the former being naked above, while in the latter genus it bore macrotrichia. *Psaroniocompsa* resembles *Boophthora* in respect of the trichiation of the wing veins but is differentiated from the latter by the vestiture of the dorsum of the thorax. The first pair of genera belong to Enderlein's *Nevermanninae*, the latter to his *Simulinae*.

Enderlein (1935) did not state to what genera or species of *Nevermanninae* *Psilocnetha scapulata* sp. et gen. n. was related, but only that the distal section of the radius and the sub-costal area were all lightly haired, radial-sector haired and basal section of the radius naked. This may be compared with his statement (1934b) that the basal section of the radius in *Cnetha* was lightly haired as were the radial-sector, the distal section of the radius and the sub-costal. *Titanopteryx* having the basal section of the radius naked above and three stripes ("eingedruckten Langsfurchen") on the dorsum of the thorax was thereby differentiated by Enderlein from *Nevermannia* which lacks these features. *Melopelphalis* is stated to be related to *Boophthora*, but the basal section of the radius, distal section of the radius, and radial-sector are all furnished with hairs in the new genus while the basal section of the radius is naked in *Boophthora*. The last pair of genera belong to Enderlein's *Simulinae*.

Enderlein (1936a: 39) erected *Miodasia* in a dichotomous key to Simuliid genera of "Mitteleuropa." By examination of the key it is possible to discover that in this genus the sub-costal area is naked, the basal section of the radius bearing, at most, two rows of hairs ("hochstens zweireihig pubescent"), distal section of radius bearing small spines, radial-sector pubescent, female claws untoothed, male hind-basitarsus swollen, spindle-shaped. The genotype is stated to be *M. opalinipennis*, which is not described except in so far as the key gives a description of the genus which is monotypic. Later he (1937) indicated that *Miodasia* was close to *Schombaueria*.

Enderlein (1936b) differentiated *Chelocnetha* from *Cnetha* by the radial-sector being naked in the former genus and haired in the latter; the hind tibia of the former is grooved. *Pselaphochir* is distinguished from *Morops* by the former having the hind basitarsus of the male spindle-shaped and the hind tibia without any projection, while the latter has the hind basitarsus small and parallel-sided and a pointed projection two-thirds down the length of the swollen hind tibia. *Pliodasina*, with the sub-costa, distal section of radius and radial-sector pubescent above, is thus differentiated from *Simulium* (as restricted by Enderlein), in which all these are naked above.

Of the family *Ectemminae* of Enderlein, *Ectemnia* has been considered at page 483, and *Pteraspispatha* at page 491. *Aspathia* was erected by Enderlein (1935) for the reception of *Simulium hunteri* Malloch. Both Malloch (1914) and Dyar & Shannon (1927) placed *hunteri* in *Simulium* (as they restricted the genus); Enderlein (1930) had placed this species in *Odagmia*, apparently on the basis of the description and without seeing authenticated specimens of the species. Enderlein (1935) identified a Simulid from Alaska as this species. He found that his specimen had a pedisulcus but lacked a caleipala and therefore placed the species in a new genus, *Aspathia*, of the sub-family *Ectemminae*, without, however, clearly differentiating it from other genera of the sub-
family then extant, *Ectenemia* and *Pternaspatha*. Both Malloch and Dyar & Shannon had treated *hunteri* as though it possessed both *caleipala* and *pedisulcus* and so this monotypic genus is synonymised with *Simulium* in the present paper.

Enderlein (1936b) amplified his description of *Pternaspatha* and indicated that it had a pubescent radial-sector, haired distal section of the radius, subcosta and basal section of radius naked and long hair on the outside of the hind basitarsus, the hairs being \( \frac{2}{11} \times \) the width of the segment in length. He differentiated *Psilozia* from *Pternaspatha* by the former having the sub-costa, the basal section of the radius, the radial-sector and the distal section of the radius sparsely pubescent and the hairs on the hind basitarsus short. *Crypteletamnia* is stated to have the basal section of the radius, the distal section of the radius, and the radial sector all pubescent, and the genus is thus differentiated from both *Pternaspatha* and *Psilozia*.

In the present paper the criteria used by Enderlein since 1930 for the discrimination of the genera dealt with above are considered to be unsatisfactory for this purpose and consequently the names fall as synonyms of *Simulium* as now restricted.

Dundubrovinulimid Baranov has been dealt with at page 478. It is isogenotypic with *Simulium* Latreille and therefore a synonym. *Pseudosimulium* Baranov (1926) is isogenotypic with *Boophthora* Enderlein (1921) and so sinks as a synonym of the latter. *Pseudosimulium* Baranov (1926), a sub-genus of *Olognia* Enderlein (1921), may be simply regarded as a synonym of *Olognia*. *Pseudonematocerca* Baranov (1926), whether regarded as a sub-genus or as a genus, is isogenotypic with *Coelthia* Enderlein (1921) and so falls as a synonym of the latter. *Echinosimulium* Baranov (1938) was erected for the larva and pupa of a species the adults of which were not known. It is quite likely that they were pathological specimens of *replancens* and *colombaschensis*, in whose company they were found. Pending further information the name must be regarded as a synonym of *Simulium* (as now restricted).

*Cleitosimulium* Seguy & Dorier (1936) was described as a sub-genus of *Simulium* as restricted by Enderlein (1930); it thus falls as a synonym of *Simulium* as restricted here.

*Gius Rubtzov appeared as a sub-genus of *Simulium* (restricted) in 1937, but the actual description is in a paper published later (1940).*

The sub-genera *Hedria* Rubtzov and *Neoalumini* Rubtzov of *Simulium* (as restricted by Rubtzov (1940)) must along with *Gius* be regarded as synonyms of *Simulium* as restricted in the present paper.

### III. Key to the Genera of the Simuliidae.

1. The radius (\( R_1 \)) joining the costa about the middle of the front edge of the wing.

   - Radial-sector (\( R_2 \)) forked, the posterior branch of the fork joining the costa some distance before the termination of the latter towards the wing-tip; macrotrichia of the anterior wing veins hair-like (Parasimulium).

29 Rubtzov, I. A. (1940). Fam. Simuliidae. *Fam. de l'U.S.S.R., Insectes Diptères* 6 (6): 1-532. At the time when the present paper was being prepared (1944) no copy of this paper had reached the libraries of either the British Museum (Natural History) or the Imperial Institute of Entomology; the former obtained a copy in April 1945. Unfortunately the only information in it that is summarised in English are the keys and descriptions of new species; the comments on classification are all in Russian.
The radius ($R_2$) joining the costa well beyond the middle of the front edge of the wing.

The tip of the radial-sector ($R_4$), if this is simple, or the tip of the posterior branch, if it is forked, joining the costa practically at the termination of the latter towards the wing-tip; macrotrichia of the anterior wing veins shorter and more bristle-like and in some genera with an admixture of spiniform macrotrichia on the costa at least (Simulium).

2. Radial-sector ($R_4$) forked; macrotrichia of the anterior wing veins bristle-like only (no spiniform ones present).

   Basal section of the radius with macrotrichia above; basal cell present; $Cu_2$ sinuous; no pediculus; no calcipala ........................................... Prosimulium.

   Basal section of the radius with macrotrichia above; basal cell present; distal section of the simple radial-sector with a single row of macrotrichia above; no pediculus; calcipala exceptionally strongly developed ........................................... Gigantodax.

   Basal section of the radius with macrotrichia above; no basal cell; distal section of the simple radial-sector with a single row of macrotrichia above; no pediculus; calcipala ........................................... Austrosimulium.

   Basal section of the radius with macrotrichia above; no basal cell; distal section of the simple radial-sector with a single row of macrotrichia above; pediculus present and in some species extremely small ........................................... Cnephia.

   Basal section of the radius with or without macrotrichia above; distal section of the radial-sector with or without macrotrichia above; calcipala present (in all but four described species in which it may be small and unobserved by the describer) ........................................... Simulium.

IV. Catalogue of the Described Species of Simuliiidae.

In the catalogue all names applied to Simuliiidae that I have discovered are listed alphabetically. The present catalogue contains over 800 names; this may be compared with the 90 entries of Kertész's (1902) Catalogus Dipterorum.

The species are arranged under the genera recognised in this paper, but it should be noted that species of Simulium (sensu lato et antiquo) which it is not possible to assign to one of these genera are listed under Simulium (restricted); these are relatively few in number and it is likely that most of them do in fact belong to Simulium (restricted).

Synonyms are printed in italics; valid names are in clarendon (bold face); named varieties are treated as synonyms but are indicated by a preceding "var."); subspecies, races and forms of various authors are also placed as

TRANS. R. ENT. SOC. LOND. 95. PART 8. (DEC. 1945.)
synonyms, but the trinomial form of the name or other indication will differentiate these from pure synonyms. Generic names used by the authors in the original descriptions are shown in every case.

The reference to the literature in which the original description of a species, var., etc. appeared is given with the names in their alphabetic position in the catalogue. Throughout, and the subsequent notes, the attachment of an author's name to a specific name indicates that the species was described under that name as a new species by that author. In the few cases where species as identified by a subsequent author are mentioned, they are shown thus—hirtipes Fries of Enderlein, i.e. the species Enderlein identified as hirtipes Fries.

The synonymy indicated has been limited to that which has been generally accepted or to that which has been proposed by authors whose published work indicates that they were in a position to study types of species concerned, or otherwise ascertain the proposed synonymy with some certainty.

Many of Enderlein's exotic species probably will also fall as synonyms sooner or later—it is surprising, for instance, that this author, who has described many species from Peru, should have failed to recognise a single specimen of any of the six species described by Knab (1914b and c) from that country.

The applications of some names of Kertész (1902), Friederichs (1919, etc.), Edwards (1920, 1924, etc.) and Enderlein (1930, etc.) differ considerably. Rather than annotate the catalogue with a mass of marks of interrogation and other symbols, a minimum of this uncertain synonymy is indicated in a series of notes. Generally the synonymy of Edwards has been followed, since his papers (e.g. Edwards (1924a)) show that he made considerable efforts to see the types of some of the older authors. The European species will remain difficult and over-numerous until some worker is able to subject all the surviving types of the older authors, Landström's types and material, Enderlein's types, Edwards' material and possibly Friederichs' material to a joint scrutiny.

When the catalogue is examined it will be found that quite a few names which had been sunk in the synonymy in the past are given as valid species. This has been done not because the present writer has investigated the matter and decided that they are valid, but because he is not convinced that the authors who sank them as synonyms had sufficient grounds for doing so. This is particularly the case with some of the names of older authors on the application of which authors have differed. The writer would suggest that these names should not be reinserted in the synonymy until carefully re-investigated. It would be better to leave them as unrecognisable species than to place them in the synonymy of any particular species when any doubt remains as to their identity.

The indications of geographical distribution have been made deliberately wide by reference to the usual geographical regions, except in some cases where an obvious service can be rendered by stating the more precise political locality. Erroneous impressions may arise from giving localities by political units as, for instance, in the case of Colombia, Ecuador, and Peru which are usually thought of as Pacific Coast countries when in fact they contain tracts that, being east of the Andes Cordillera watershed, are Amazonian. To give more precise localities would be impossible owing to considerations of space.

On the other hand, species that are known only from a country at the boundary of one of the major zoogeographical regions with another cannot easily or safely be assigned to a zoogeographical region. For this reason Mexico, China and Japan and some other special localities such as the Canary
Isles have been mentioned. To simplify matters, the Palearctic has been considered as divided into Europe (with U.S.S.R. west of the Urals), Siberia, Asia Minor, North Africa, China and Japan. When a species has been recorded from only one of these areas it is indicated as coming from it.

SIMULIIDAE.
PARASIMULIIINAE.
PARASIMULIUM.
furcatum Malloch (1914 : 24) Parasimulium California.

SIMULINAE.

PROSIMULIUM.

blechum Enderlein (1929 : 224) Prosimulium—see tamoscari Enderlein.
boralis Zetterstedt (1840 : 514) Simulium—see ferrugineum Wahlberg.

canadalicum Smart (1944b : 132) Simulium—see tamoscari Enderlein.
exigens Dyar & Shannon (1927 : 10) Prosimulium Nearctic.
harzyi Stains & Knowlton (apud Stains & Knowlton 1943).
ferrugineum Wahlberg (1840 : 110) Simulium—see fultipes Edwards.
borealis Zetterstedt (apud Zetterstedt 1850).
fuhlpipes Edwards (1921) Prosimulium—see rufipes Meigen.
fusipes Roser (1840 : 52) Simulium (see notes) Europe—see tamoscari Enderlein.
galli Edwards (1921 : 141) Prosimulium—see rufipes Meigen.
hardy Stains & Knowlton (1940 : 78) Eusimulium—see exigens Dyar & Shannon.
hiripes Fries (1824 : 17) Simulium (see notes) Holartic.

Prosimulium—see rufipes Meigen.
pseudokirihipes Smart.
hiripes kirihipes Fries of Rubtzov.
hiripes tridens Fries of Rubtzov.
irritans Rubtzov (1940 : 52a) Prosimulium (Prosimulium) kamtschaticum var.—see kamtschaticum Rubtzov.
sapparoensis Shiraki (apud Kono & Takahasi 1940).
johannseni Hart (1912 : 32) Simulium Nearctic.
var. irritans Rubtzov.
macroproa Lundström (1911 : 203) Melusina Europe.
nigripes Enderlein (1925 : 202) Prosimulium (see notes)—see hiripes Fries.
onchodacticum Dyar & Shannon (1927 : 4) Prosimulium Nearctic.
pancerastes Dyar & Shannon (1927 : 10) Prosimulium Nearctic.
pexifrons Enderlein (1925 : 203) Prosimulium—see rufipes Meigen.
pieripes Stephens (1829 : 254) Simulium (nomen nudum)—see hiripes Fries.
pleural Malloch (1914 : 17) Prosimulium Nearctic.
pseudohirtipes Smart (1944b: 132) Simulium—see hirtipes Fries.

rufipes Meigen (1830: 311) Simulium (see notes) Holarctic.
galli Edwards (apud Edwards 1933a).
fidipes Edwards (apud Edwards 1933a).
tenitcal Enderlein (apud Rubtzov 1940).
perisfons Enderlein (apud Rubtzov 1940).
sapporoensis Shiraki (1935: 10) Simulium (see jezoninwu Matsumura).
tenuical Enderlein (1925: 203) Prosimulium—see ruflpes Meigen.
tomosvaryi Enderlein (1921b: 215) Schonbaueria (see notes) Europe.
fulvipes Edwards (apud Edwards 1933a).
tridens Enderlein (1921: 213) Simulium (Prosimidium) hirtipes—see Mrlipes Fries.
galli Edwards (apud Edwards 1933a).
lenuical Enderkin (apud Rubtzov 1940).
pexifrons Enderlein (apud Rubtzov 1940).
tridenlatum Rubtzov (1910: 264) Prosimulium (Prosimidium) hirtipes—see Mrlipes Fries.
sapporoensis Shiraki (1935: 10) Helodon—see jezoninwu Matsumura.
tenitcal Enderlein (1925: 203) Prosimulium—see rufipes Meigen.
tomosvaryi Enderlein (1921b: 215) Schonbaueria (see notes) Europe.
heymonsi Enderlein (1921a: 200 & 1921b: 213) Cnetha—see pallipes Fries.

Invenustum Walker (1848: 110) Simulium Nearctic.
latifrons Enderlein (1925: 204) Helichia Europe.
litimucro Enderlein (1925: 204) Helichia Europe.
lesnei Seguy (1925b: 107) Simulium Europe.
lyra Lundström (1912: 17) Melusina Europe.
montanum Philippi (1865: 633) Simulium Neotropical.
mutatum Malloch (1914: 20) Prosimulium Nearctic.
mutatum permutatum Dyar & Shannon.
ong Rubtzov (1940: 322 & 497) Simulium (Astega) Asia Minor.

pallipes Fries (1824: 19) Simulium (see notes) Paleartic.
heymonsi Enderlein (apud Rubtzov 1940).
pecuarum Riley (1887: 493) Simulium Nearctic.

Annulus Lundström (1911: 17) Melusina (see notes) Europe.
adriaticum Tomnor (1925: 235) Simulium Australian.

biseriatum Rubtzov (1940: 330 & 496) Simulium (Astega) Tibet.
borealis Malloch (1918: 41) Prosimulium Nearctic.

CNEPHIA.

Annulus Lundström (1911: 17) Melusina (see notes) Europe.
adriaticum Tomnor (1925: 235) Simulium Australian.

CNEPHIA.

annulus Lundström (1911: 17) Melusina (see notes) Europe.
adriaticum Tomnor (1925: 235) Simulium Australian.

biseriatum Rubtzov (1940: 330 & 496) Simulium (Astega) Tibet.
borealis Malloch (1918: 41) Prosimulium Nearctic.

duodecimatum Rubtzov (1940: 310 & 493) Simulium (Stegopterna) East Siberia.
Simulid Co. Enderlein (1925 : 206).

Cnetha—see pecetium Riley.

terebrans Tomoir (1925 : 237) Simulium Australian.

tibiale Macquart (1834 : 174) Simulium (see notes) Europe.

tredeecimatum Edwards (1920 : 216) Simulium (see notes) Europe.

trigonum Lundstrom (1911 : 14) Melasina Europe.

victorias Roubaud (1906 : 521) Simulium Australian.

weindorferi Tomoir (1925 : 248) Austrosimulium Australian.

GIGANTODAX.

antarcticum Bigot (1888 : 15) Simulium Neotropical.


bolivianum Enderlein (1925 : 205) Gigantodax Neotropical.


dometicum Blanchard in Gay (1852 : 353) Simulium (nomen nudum).


pennipunctum Enderlein (1934a : 274) Simulium (nomen nudum).


wrighti Vargas (1944 : 37) Simulium (Gigantodax) Mexico.

SIMULIUM (restricted).


adersi Pomeroy (1922 : 459) Simulium hirsutum var. Ethiopian.

adolf-friedericianus Enderlein (1930 : 94) Anasolen Ethiopian.

aequilucatum Lutz (1910 : 259) Simulium (Simulidium) E. Siberia.

affinis Meunier (1907 : 387) Simulium (see notes) Fossil.

affinis Stephens (1829 : 254) Simulium (nomen nudum)—see variegatum Meigen.
500 Dr. John Smart on the classification

africanum Gibbins (1934 : 95) Simulium Ethiopian.
agnatum Baranov (1936 : 259, 272) Simulium Europe.
columbaccense Fabricius of Enderlein (1936a: 41) (apud Baranov 1936).
sbergi Rubtzov (apud Rubtzov 1940).
albicinctus Enderlein (1934a : 277) Acronegma Neotropical.
albinea Enderlein (1936b : 155) Pteronarspatha Neotropical.
albimanum Lutz (1909 : 132) Simulium — see orbitale Lutz,
albipileata Enderlein (1926 : 140) Cnetla Europe.
albivirgulatum Wansor & Henrard (1944 : 35) Simulium Ethiopian.
albopictum Lane & Porto (1941 : 193) Simulium Neotropical.
aldrichiana Enderlein (1936b : 120) Schönbaueria Neotropical.
alternans Enderlein (1921a : 200 & 1921b : 219) Simulium Europe.
altripartitum Ronland & Grenier (1943 : 304) Simulium Ethiopian.
amazonense Lutz (1917 : 64) Simulium — see amazonicum Goeldi.
amazonicum Goeldi (1905 : 138) Simulium Neotropical.
amazonense Lutz (misspelling),
equirem Lutz (apud Lutz 1917),
minum Sureif & Gonzalez-Rincones, latzi Knab, latzi Malloch, nitudum Malloch (apud Lutz 1917),
mondulatum Lutz (apud Lutz 1917),
anderlecki Baranov (1936 : 263, 271) Odagmia ornata form — see ornata Meigen.
angrensis Pinto (1932 : 683) Simulium Neotropical.
angustifrons Enderlein (misspelling),
angustifrons Enderlein (1934a : 292) Trichodagmia — see burgham Smart.
angustimanus Enderlein (1921a : 200 & 1921b : 217) Odagmia — see ornata Meigen.
angustipes Edwards (1915 : 40) Simulium (see notes) — see aternum Fries.
angustitarsis Enderlein (1934a : 290) Trichodagmia — see hoffmanni Vargas.
angustitarsis Landström (1912 : 22) Melaina (see notes) Palearctic.
anulatum Philipp (1865 : 634) Simulium Neotropical.
anulipes Becker (1908 : 72) Simulium — see rubicornis Macquart.
anulipes Shiraki (1935 : 49) Simulium — see japonicum Matsumura.
anulitarsis Zetterstedt (1838 : 602) Simulium N. Europe.
anulitibia Enderlein (1922 : 69) Wilhelmina equina var. — see equimun Linnaeus.
anomala Eversmann (1834 : 422) Simulium (nomen nudum) (apud Sherborn 1923).
antillarum Jennings (1915 : 200) Simulium Antilles.
antunesi Lane & Porto (1940 : 189) Eusimulium Neotropical.
akii Takahasi (1941 : 86) Odagmia Japan.
akakace Matsumura (1921 : 85) Simulium — see venustum Say.
arctica Enderlein (1936b : 119) Schönbaueria — see rivae Smart.
arctium Malloch (1911 : 37) Simulium Neotropical.
simile Malloch (apud Dyar & Shannon 1927).
hetericum Knowlton & Rowe (apud Stains & Knowlton 1943).
igiresscum Knowlton & Rowe (apud Stains & Knowlton 1943).
coris Twinm (apud Stains & Knowlton 1943).
arense Rubtzov (1940 : 419 & 515) Simulium (Simulium) East Siberia.
argentata Enderlein (1936b : 125) Thyrsopelma Neotropical.
argentostriatum Strobl (1898 : 594) Simulium (see notes) Europe.
argus Williston (1893 : 253) Simulium Neotropical.
argypecta Meigen (1838 : 52) Simulium (see notes) — see ornatum Meigen.
argyrocinetum Meinere (1913 : 332) Simulium Oriental.
argyropeza Meigen (1801 : 96) Atraedics (see notes) Europe.
arias Seguy (1925d : 236) Simulium Europe.
arolndi Gibbins (1937b : 299) Simulium Ethiopian.
asakake Smart (1944b : 131) Simulium Neartic.
auera Fries (1824 : 16) Simulium (see notes) Holartic.
auera primus Baranov.
aurea secundus Baranov.
palenum Knowlton & Rowe (apud Stains & Knowlton 1943).
auroacuminatum Malloch (1914 : 27) Simulium—see meridianum Bellardi.
aurosimile Pomeroy (1920 : 78) Simulium Ethiopian.
aureola Meigen (1815 : 296) Simulium Europe.
auroleni Enderlein (apud Rubtsov 1940).
aupellatum Enderlein (1934a : 236) Simulium Neotropic.
aurostriatum Lutz (1910 : 215) Simulium—see infuscatum Lutz.
auropustulatum Edwards (1915 : 323) Simulium—see venustum Say.
auritatum Hoffmann (1930a : 51) Simulium—see metallicum Bellardi.

babici Baranov (1935 : 261, 273) Olaugnia ornata form—see ornata Meigen.
baiensis Pinto (1932 : 685) Simulium Neotropic.
baracorne Smart (1944b : 133) Simulium Europe.
ruficorne Baranov (apud Smart 1941b).
ruficorne prima Baranov.
ruficorne secunda Baranov.
baranovi Smart (see Addendum) Simulium Europe.
tenmotarous Baranov.
barbaricem Seguy (1930 : 51) Simulium N. Africa.
barbatipes Enderlein (1934a : 277) Acrepophora Neotropic.
barbativentris Enderlein (1929a : 16) Dheo Germany.
barnardi Gibbins (1938 : 22) Simulium Enderlein.
bartulici Baranov (1936 : 262, 274) Olaugnia ornata form—see ornata Meigen.
beameri Stains & Knowlton (1943 : 279) Simulium Neartic.
beckeri Roubaud (1906 : 520) Simulium—see ruficorne Macquart.
beugangaricum Baranov (1925 : 10) Neartic.
beweinki Enderlein (1926 : 142) Simulium Europe.
bhningi Enderlein (1926 : 142) Simulium Europe.
bequaerti Gibbins (1936b : 133) Simulium Enderlein.
Dr. John Smart on the classification

502


buxtoni Austen (1923: 275) Simulium buxtoni Austen — see irakae Smart.


caffrariana Enderlein (1933: 359) Cnetha — see nigritasis Coquillett.

caffrica Enderlein (1936: 117) Cnetha — see nigritasis Coquillett.


mooseri Dampf (apud Bequaert 1934).

calyptrum Baranov (1926b: 189) Simulium reclus var. — see reclus Linnaeus.

cana Meigen (1838: 52) Simulium Europe.

canadense Headle (1932: 14) Simulium virgatum Nearctic.

fritaturn Twinn (apud Stains & Knowlton 1943).

canariense Seguy (1921: 292) Simulium Canary Islands.

canescentis Breme of Zetterstedt (misspelling).

canescentis Breme of Zetterstedt Simulium (1860: 6490) — see canescentis Breme.

canoniceps Dyar & Shannon (1927: 22) Eusimulium Nearctic.

capensis Enderlein (1935: 361) Thysopelma — see melasformaformis Pomeroy.

catarinensis Pinto (1932: 695) Simulium Neotropical.

catarinensis Pinto (of Lane & Porto 1910).

catarinensis Pinto (of Lane & Porto 1910: 194) Simulium — see catarinensis Pinto.

cauveri Rubtsov (1940: 387) Simulium (Odagoria) ornatum var. — see ornatum Meigen.

cavum Gibbons (1933: 26) Simulium Ethiopian.

abscendum Gibbons (apud Gibbons 1938).

cerberus Enderlein (1921a: 200 & 1921b: 74) Simulium Fossil.

cervicornutum Pomeroy (1920: 73) Simulium Ethiopian.


dalea Knab (1914: 81) Simulium Neotropical.

dalea Knab (1914: 81) Simulium Pacific.

dalea Knab (1914: 81) Simulium Pacific.
of the Simuliidae (Diptera).

costaricense Vargas.
costaricense Vargas (1945a : 5) Simulium (Simulium)—see costaricense Smart.
costatum Friederichs (1929a : 11 & 1921 : 51) Simulium (see notes) Palearctic, Neotropical.
crassitarsis Macquart (1831 : 173) Simulium (see notes) Europe.
form virgina Baranov.
form decolorata Baranov.
curvitas Rubtzov (1940 : 434 & 519) Simulium (Simulium) N.E. Siberia.
damnosum Theobald (1903 : 40) Simulium Ethiopian.

debedega Meillon (1934 : 253) Simulium Ethiopian.
decolorata Baranov (1936 : 264, 276) Odagmia croatica form—see croatica Baranov.
decorum Walker (1848 : 112) Simulium Nearctic.
decorum katsuni Dyar & Shannon.
delphini Villesneuve (1918 : 96), Simulium vitatum var.—see bezi Corti.
dentatum Puri (1932e : 1135) Simulium Oriental.
dentatum Wanson & Heurard (1944 : 40) Simulium griseicolle var.—see griseicolle Becker.
dentulosum Roubaud (1915 : 294) Simulium Ethiopian.
gilipes Pomeroy (apud Gibbins 1938).
gilipes Pomeroy (apud Gibbins 1938).

chilense Philippi (1865 : 634) Simulium Neotropical.
enotropical, chilense Philippi in Rondani (1963 : 90) Simulium Neotropical.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.
chilus Rubtzov (1940a : 194), Simulium (Simulium) Asia.


decorum of Sherborn (1933 : 959)


devonim of Sherborn (1933 : 959)

---

diabatique Mallochi (apud V. V., 1913a).

digitatum Puri (1932 c : 1132) *Simulium* Neotropical.

digitatum Edwards (1928 : 61) *Simulium*—see *grosii* Brumpt.

dinelli Joan (1912 : 363) *Simulium* Neotropical.

---

dipunctatum Mallochi (apud Knab 1913).

distinctum Lutz (1910 : 311) *Simulium*—see *perita* Kollar.

distinctum Mallochi (1913 : 133) *Simulium*—see *tricolor* Mallochi.

divergens Pomeroi (1922 : 459) *Simulium*—see *refebrum* Macquart.

diversibranchium Lutz (1910 : 238) *Simulium* Neotropical.

diversispecum Lutz (1910 : 258) *Simulium* Neotropical.

diversipes Edwards (1923 : 333) *Simulium*—see *refebrum* Macquart.

djallonense Roubaut & Greuter (1913 : 298) *Simulium* Ethiopian.

djerapense Baranov (1936 : 258, 270) *Simulium* Europe.

donavani Vargas (1943 b : 359) *Simulium* (*Eusimulium*) Mexico.

dubium Mallochi (1922 : 459) *Simulium* *hiratata* var.—see *hiratata* Pome- roy.

duodecimum Gibbins (1936 : 223) *Simulium* Ethiopian.


ecuadoriensis Enderlein (1934 b : 279) *Arapopogon*—see *neogastropus* Enderlein.

ecuadoriensis Gibbins (1943 : 391) *Simulium* (nomea *indum*) see *bisnorum* Gibbins.

egregium Seguy (1930 : 51) *Simulium* N. Africa.

---

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.

edges Meigen (1818 : 296) *Simulium* (see note)—see *repans* Meinaus.
of the Simuliidae (Diptera).


galeratum Edwards (1920 : 231) Simulium reftians var.—see reftians Linnaeus.
gallinum Edwards (1932 : 108) Simulium bissomii var.—see bissomii Roubaud.
gaudetum Knab (1914b : 81) Simulium Neotropical.
gerstaeckeri Enderlein (1936a : 41) Simulium Europe.
giganteum Rubtsov (1940 : 398 & 503) Simulium (Schibekia) West Siberia.
gilicipes Pomeroy (1920 : 75) Simulium—see dentatus Roubaud.
glaucophthalmum Knab (1914c : 123) Simulium Neotropical.
glaucum Coquillett (1903 : 97) Simulium—see elitans Zetterstedt.
glauromayse Baranov (1936 : 257, 270) Simulium reftians—see reftians Linnaeus.
gracilipes Edwards (1921 : 143) Simulium N. Africa.
graveyi Puri (1933b : 803) Simulium Oriental.
grisecollis Becker (1906 : 78) Simulium Ethiopian.
var. dentatulum Wanson & Henrard.
var. trisphaerae Wanson & Henrard.
digonine Edwars (apud Puri (1932)).
grisescens Brunetti (1911 : 283) Simulium Oriental.
var. pelarmum Puri.
grisocum Coquillett (1898 : 69) Simulium Neotropical.
grenlandicum Enderlein (1936b : 114) Phoecina—see asakake Smart.
grenlandicum Enderlein (1933 : 363) Simulium Neotropical.
gueldinini Baranov (1936 : 262, 273) Odagoina ornata form—see ornata Meigen.
guimari Becker (1908 : 72) Simulium Canary Isles.
gurneyae Senior-White (1922 : 130) Simulium Oriental.
haarupiana Enderlein (1936b : 127) Tri-
choderma Neotropical.
haikeri Edwards (1928 : 60) Simulium
Oriental.
haematopotum Malloch (1911 : 62)
Simulium Neotropical.
haereli Twinn (1938 : 50) Simulium—
see propinquus Hearle.
halonensis Takahasi (1940 : 70) Odonatia
Manchuria.
hargreavesi Gibbins (1934 : 83) Simul-
ium—see campanum, Lutz.
hebeticolor Lutz (1910 : 267) Simulium—
see simplicicolor Lutz.
heldenreichi Enderlein (1921b : 219)
Simulium Europe.
henardi Gibbins (1911 : 210) Simul-
ium see dipterus Pomeroy.
heptapotamicum Rubtzov (1940 : 351 &
500) Simulium (Nevanermin) Siberia.
heringi Enderlein (1925 : 209) Simulium
Europe.
hessii Gibbins (1941 : 210) Simulium—
see dipterus Pomeroy.
himalayense Puri (1932a : 885) Simul-
ium Oriental.
hippopotamus Malloch (1914 : 28) Simul-
ium—see propinquus Coquillett.
hirsutelleris Meillon (1937 : 395) Simul-
ium Ethiopian.
hirsutum Pomeroy (1922 : 458) Simul-
ium—see dipterus Pomeroy.
var. dubium Pomeroy.
var. seriens Meillon.
hirticosta Lutz (1909 : 135) Simulium—
Simulium Neotropical.
hirtinervis Edwards (1928 : 63) Simul-
ium Oriental.
hirtipannus Puri (1932a : 509) Simul-
ium Neotropical.
hirtipupa Lutz (1910 : 260) Simulium
Neotropical.
hissetsum Gibbins (1936 : 138) Simul-
ium Ethiopian.
h-nigrum Abreu (1922 : 19) Melanina
Canary Isles.
holmbergi Vargas (1913a : 138) Simul-
ium Neotropical.
angustifrons Enderlein (apud Vargas
1913a).
hovathii Enderlein (1922 : 67) Nev-
manerminia Europe.
howletti Puri (1932d : 505) Simulium
Oriental.
ishikawai Takahasi (1940 : 71) Simulium Manchuria.
ivashentzovi Rubtsov (1940 : 414 & 506) Simulium (Wilhelmia) Europe.
aecutium Rubtsov (1940 : 365 & 508) Simulium (Gnus) East Siberia.

delta Enderlein (1921b : 214) Hellicia—see falcula Enderlein.
dizeni Enderlein (1922 : 73) Simulium—see tuberosum Lundstrom.
epurea Shiraki (1935 : 45) Odagmia—see nacojezi Smart,
epureum Matsumura (1931 : 407) Simulium Japan.
ximides Shiraki (apud Kono & Takahasi 1940).

dennisi Malloch (1914 : 41) Simulium Neartic.
dichoensis Smart (1941b : 133) Simulium (see notes) Asia Minor.
flavipes Austen (apud Smart 1941b).
jolyi Rouband (1906 : 142) Simulium Pacific.
laciuriatm Edwards (apud Edwards 1932).
kamloopsi Hearde (1932 : 12) Simulium Neartic.
healri Twinn (apud Stains & Knowlton 1943).
kuskulaticum Rubtsov (1940 : 442) Simulium (Simulium) var. stanim—see stanim Say.
kariyai Takahasi (1940 : 64) Hellicia Manchuria.
khanai Dyar & Shannon (1927 : 31), decorum Simulium—see decorum Walker.

akunteum Gibbins (1938 : 23) Simulium Ethiopian.
kenaie Meillon (1940 : 418) Simulium Ethiopian.
kenyanum Seguy (1938 : 225) Simulium Ethiopian.
kerteszi Enderlein (1922 : 68) Neumannia Europe.
viol. melanolabrichum Enderlein (1924 : 47).
serbicum Baranov (apud Enderlein 1930 : 80).
kiritshenkol Rubtsov (1940 : 389 & 513) Simulium (Odagmia) Persia; Baluchistan.

knokci Enderlein (1929a : 77) Cnetha Europe.
knowltoni Twinn (1938 : 53) Simulium Neartic.
koidzumii Takahasi (1940 : 67) Titanoptera Manchuria.
kondici Baranov (1926a : 161) Odagmia—see variegata Meigen.
konsuljfi Enderlein (1924 : 236) Odagmia—see ornata Meigen.
kozlovi Rubtsov (1940 : 371 & 510) Simulium (Odagmia) Tibet.

kuznetzovi Rubtsov (1940 : 405 & 503) Simulium (Schönhaueria) Europe.
laciniatum Edwards (1921b : 572) Simulium—see jolyi Rouband.
lane-Portieri Vargas (1941 : 118) Simulium Neotropic.

pilosum Lane & Porto (proloc. pilosum Knowlton & Rowe).
lania Limnaeus (1771 : 541) Culex (see notes) Europe.
laticla Enderlein (1936b : 114) Cryptocerina—see orsovae Smart.
laticla Enderlein (1934a : 291) Trichodagmia Neotropic.
latinanus Enderlein (1921a : 200 & 1921b : 218) Simulium—see reptans Limnaeus.
latipes Meigen (1804 : 95) Atractocera (see notes) Palearctic, Oriental.
var. tibodense Edwards.
var. tsoariense Edwards.
latipollux Enderlein (1936b : 127) Metomphilus Ethiopian.
latistram — Senior-White (1922 : 129)
Simulium—see striatum Brunetti.
latitarsis Enderlein (1931a : 289) Tri-
cholaquadnia Neotropical.
lepidum Meillon (1935 : 330) Simulium
Ethiopian.
etabum Meillon (1935 : 330) Simulium
Ethiopian.
latitarsis Enderlein (1931a : 282) Ecten-
naspis—see simulium Smart.
etabum Enderlein (1921a : 200 and 1921d : 78) Simulium—see tanage
Smart.
limbatum Enderlein (1932a : 232) Eclem-
naspis—see siewani Smart.
limbatum Enderlein (1915a : 280) Siiindiuiii
Neotropical,
limeata Meigen (1803 : 95) Atrachoeera
(see notes)—see eymnum Linnaeus.
limealum Puri (1932c : 1125) Simulium—see
novoEntommu Puri,
limeothorax Puri (1932c : 520) Simulium
Oriental.
litorale Baranov (1937 : 158) Simulium
colubaczense—see cnobi-
chensis Fabricius.
lutzi Schellenberg (1903 : 21) Hirta—
see varioptum Mg.
loangolense Rouband & Grenier (1943 : 293) Simulium
Ethiopian.
lonjiunguis Enderlein (1933b : 126) Thysopelma Oriental.
lugubre Lutz (1928 : 46) Simulium Neotropical.
lumbarus Meillon (1944 : 117) Simulium
Ethiopian.
lustromi Enderlein (1921a : 200) Necevannatia (see notes) Europe.
lurybayae Smart (1914b : 152) Simulium Neotropical.
anguiferous Enderlein (apud Smart 1914b).
intectoria Stephens (1829 : 254) Simulium (nomen nudum)—see varioptum Meigen.
lutzi Knab (1913 : 151) Simulium—see
anatonicum Goebel.
lutzi Malloch (1911 : 11) Simulium—see
anatonicum Goebel.
lutziia Enderlein (1931 : 291) Tricho-
naspis (see notes)—see pertinax
Kollar.
lutzianus Pinto (1932 : 718) Simulium
Neotropical.
macea Enderlein (1931a : 281) Ecten-
naspis—see molly Vargas.
macea Enderlein (1931a : 275) Dasep-
msona Neotropical.
maemahoni Meillon (1940 : 446) Simul-
um Ethiopian.
maculata Meigen (1804 : 95) Atrachoeera
(see notes) Palearctic.
maculatum ussuriicum Rubtsov.
mogoeae Meillon (1935 : 323) Simulium
Ethiopian.
majore Lane & Porto (1940 : 192) Simul-
um Neotropical.
mallochii Enderlein (1925 : 208) Wilhel-
mnia (see notes) Neotropical.
malyshyevi Dorogostajskii, Rubtsov &
Vlasenko (1935 : 112 and 201)
Simulium Siberia.
manicata Enderlein (1931a : 291) Tri-
cholaquadnia Neotropical.
marathrimi Fairchild (1940 : 715) Simulium Neotropical.
marginala Meigen (1815 : 293) Simulia
(see notes) Europe.
martinezi Vargas (1943a : 137) Simul-
um Neotropical.
manzana Enderlein (apud Vargas 1943a).
masabae Gibbins (1934 : 79) Simulium
Ethiopian.
mathesoni Vargas (1931b : 350) Simulium Mexico.
mediovittatum Knab (1915a : 77) Simulium Xearctic.
mellita Enderlein (apud Stains & Knowlton 1913).
melivei Pinto (1925 : 69) Simulium equinum var.—see equinum
Linnaeus.
medusaeformis Pomeroy (1920 : 76) Simulium Ethiopian.
medusa Gibbins (apud Gibbins 1938).
medusa Gibbins (apud Stains & Knowlton 1913).
medusa Meillon (apud Gibbins 1938).
meheyi Enderlein (1926 : 141) Simulium
Europe.
melanopus Edwards (1929 : 13) Simul-
um Oriental.
mendozana Enderlein (1936b : 123)
Potomocorpa Oriental.
mellita Enderlein (apud Stains & Knowlton 1913).
mellita Enderlein (apud Stains & Knowlton 1913).
meridionale Riley (1886 : 513) Simul-
um Xearctic.
metallicum Bellardi (1859: 72) Simulium Neotropical.
acidum Hoffmann (apud Bequaert 1934).
metatarsalis Brunetti (1911: 284) Simulium Oriental.
macroceri Smart (1941b: 133) Simulium — see affinis Meunier.
mexicanum Enderlein (1931b: 190) Henrieta—see paquc Vargas.
mexicanum Bellardi (1862: 6) Simulium Neotropical.
uacapnactatum Malloch (apud Bequaert 1934).
tropidum Hoffmann (apud Bequaert 1934).
miniatum Enderlein (1934a: 275) Dasyplenum Neotropical.
miniatum Enderlein (1934b: 194) Trichiadum—see macraceri Vargas.
minuscolum Lutz (1911: 273) Simulium—see amazonicum Goedli.
minissimum Zetterstedt (1850: 3422) Simulium—see pusillum Fries.
minidium Lagger (1896: 202) Simulium—see venustum Say.
minidium Struef & Gonzalez-Rincónes (1911: 290)—see amazonicum Goedli.
molestum Harris (1862: 601) Simulium—see venustum Say.
mollis Vargas (1943a: 142) Simulium Neotropical.
moorii Enderlein (apud Vargas 1943a).
monoceros Roubaud & Grevier (1913: 290) Simulium Ethiopian.
monitorium Enderlein (1921a: 200 and 1921b: 221) Simulium—see poliae Smart.
monroeola Friederichs (1923a: 218 & 1921: 43) Simulium Europe.
moosheim Edwards (apud Edwards 1920).
movieri Hampf (1927: 225) Eusimulium—see callidum Dyar & Shannon.
murjapini Smart (1941: 133) Simulium Japan.
papadica Shiraki (apud Smart 1944).

of the Simuliidae (Diptera).
nitidifrons Edwards (1920 : 226) *Simulium ornatum* var. (see notes)—see *ornatum* Meigen.
—see *anamorphonic* Goeldi.
nitidum Malloch (1912 : 652) *Simulium*—see *ornatum* Meigen.
nobile Meijere (1907 : 206) *Simulium* Palearctic.
nobilis Edwards (apud Puri 1925).
notatum (nomen nudum) Edwards (1926).
notatum (nom. nudum) Edwards (1926).
northern Edwards (1928)
notum Edwards (1926).
nobilis Edwards (1926).
notatum (nom. nudum) Edwards (1926).

notatum (nomen nudum) Edwards (1926).
notatum (nom. nudum) Edwards (1926).
northern Edwards (1928)
nobilis Edwards (1926).
notatum (nom. nudum) Edwards (1926).
ottawaense Twinn (1936: 146) Simulium Nearctic.
pallidum Puri (1932c: 529) Simulium Oriental.
palmatum Puri (1932c: 526) Simulium grisescens var.—see grisescens Brunetti.
palmeri Pomeroy (1922: 462) Simulium Ethiopian.
palnense Puri (1933b: 807) Simulium Oriental.
pawanatum Puri (1932e: 526) Simulium grisescens var.—see grisescens Brunetti.
paimeri Pomeroy (1922: 462) Simulium Ethiopian.
palnense Puri (1933b: 807) Simulium Oriental.
pawansum Malloch (1914: 36) Simulium Nearctic.
pavanum Enderlein (1921a: 200 & 1921b: 221) Simulium Europe.
pasitha Heyden (1870: 239) Simulium Fossil.
pattoni Senior-White (1922: 129) Simulium Oriental.
pavlovskii Ruttzov (1940: 530) Simulium (Gloss) E. Siberia.
paynei Vargas (1942b: 245) Simulium (Eusimulus) Mexico.
bilimekae Smart.
meridiana Enderlein (apud Vargas 1942b).
peeti Enderlein (1921a: 200 & 1921b: 216) Schenbacteria Europe.
perflavum Roubaud (1906d: 518) Simulium Neotropical.
perissum Dyar & Shannon (1927: 43) Simulium ornatum (see notes)—see ornatum Meigen.
praria Baranov (1926: 192) Neervannia aureum var.—see aureum Fries.
praria Baranov (1926: 186), Wilhelmia equina—see equina Linnaeus.
praria Baranov (1926: 191), Odagmia rufecorne—see rufecorne Smart.
praria Baranov (1926: 189), Odagmia ornata—see ornata Meigen.
praria Baranov (1926: 185), Wilhelmia stydata—see stydata Baranov.
pritzkowi Enderlein (1926: 139) Cnetha Europe.
profundale Baranov (1937: 168) Simulium colombacensense race—see colombacensense Fabricius.
proximus McAtee (1921: 22) Simulium Nearctic.
pruinum Lutz (1910: 250) Simulium Neotropical.
philitus Pinto (1932: 729) Simulium Neotropical.
philaratum Philippa (apud Pinto 1932).
phoronomformis Meillon (1937: 399) Simulium Ethiopian.
pieta Meigen (1836: 53) Simulia (see notes) Europe.
pictipes Hagen (1879: 305) Simulium Nearctic.
plaium Comstock (apud Malloch 1914).
plasum Knowlton & Rowe (1934: 580) Eusimulus—see aureum Fries.
plasum Lane & Porto (1939: 168) Simulium—see lane-porteri Vargas.
piperi Dyar & Shannon (1927: 33) Simulium Nearctic.
pisicidium Riley (1870: 387) Simulium—see vernalimum Say.
placidum Knab (1915b: 281) Simulium Neotropical.
picea Smart (1944: 132) Simulium Europe.
montanum Enderlein (apud Smart 1944).
polare Ruttzov (1940: 422) Simulium (Simulium) tuberosum var.—see tuberosum Lundström.
posicata Meigen (1838: 52) Simulia (see notes)—see replans Linnaeus.
pradorum Friederichs (1921: 40), Simulium ornatum (see notes)—see ornatum Meigen.
prima Baranov (1926: 192) Nevermannia aureum var.—see aureum Fries.
prima Baranov (1926: 186), Wilhelmia equina—see equina Linnaeus.
prima Baranov (1926: 191), Odagmia rufecorne—see rufecorne Smart.
prima Baranov (1926: 189), Odagmia ornata—see ornata Meigen.
prima Baranov (1926: 185), Wilhelmia stydata—see stydata Baranov.
pritzkowi Enderlein (1926: 139) Cnetha Europe.
pseudocolumbaczense Baranov (1936: 255, 269) Simulium reptans—see reptans Linnaeus.
pseudoequinum Seguy (1921: 295) Simulium Canary Isles.
pseudohaematoporum Hoffmann (1930b: 295) Simulium Mexico.
pseudo-latipes Abreu (1922: 25) Melas-
ima Canary Isles.
pseudomedusaefonnis Meillon (1936: 212) Simulium—see medusaformis Pomeroy.
pseudoneareticum Rubtzov (1940: 356 & 499) Simulium—see notes.

rubiginosa Enderlein (1934a: 287) Chiro-
stilbia Neotropical.

quad Baranov (1926: 186), Wilhelmia—see equina Linnaeus.
quercus Twinn (1935: 117) Eusimul-
ium—see quercus Dyar & Shannon.
ramosum Puri (1932b: 905) Simulium—see notes.
receptans Linnaeus (1758: 603) Culic—see notes Palaeartetic.
pulchella Mennier (1907: 397) Simulium Fossil.
pulchripes Austen (1925: 4) Simulium Asia Minor.
pulchrum Philippi (1865: 633) Simulium Neotropical.
pulverulentum Knab (1914a: 177) Simulium Neotropical.
punctativentris Enderlein (1936b: 118) Acrotyllus Neotropical.
pungens Meigen in Panzer (1806: tab. 8) Atractocera (see notes) Europe.
pusilla Fries (1824: 16) Simulium Europe.
pygmaea Zetterstedt (apud Edwards 1924).

rotenonius Zetterstedt (1838: 802) Simulium (see notes) Europe.
puri Meigen (2015), elegans Meigen (apud Edwards 1915),
var. Zetterstedt (apud Edwards 1921).

rhodesiensis Meillon (1942a: 90) Simulium Ethiopian.
rileyana Enderlein (1922: 75) Boophthora—see venustum Say.
rivulare Planh. (1844: 4) Simulium—see rivulare Meigen.
rivulum Twinn (1935: 120) Eusimulium Nearctic.
rubinus Pomeroy, reptans pseudocolumbaczense Baranov,
relictum Rubtzov (1940: 425 & 516) Simulium (Simulium) East Siberia.
reptans Linnaeus (1758: 603) Culic—see notes Palaeartetic.

rubinatus Enderlein, var. rostata Lundström, var. truncata Lundström.
form ornata Meigen.
form calabriam Baranov,
form reptans Baranov.
form glutinacens Baranov.
form palaeartetic Baranov.
form gaius Meigen.

rubiginosa Enderlein (1934a: 287) Chiro-
stilbia Neotropical.
of the Simuliidae (Diptera).

rubrollavifemur Rubtzov (1940 : 436, 518) Simulium (Simulium) Sin-Kiang.
rubtzovi Smart (see Addendum) Simulium Siberia.
similis Rubtzov.
rufa Meigen (1838 : 54) Simulium Europe.
var. fasciatum Puri.
ruficorne Baranov (1926 : 191) Odagmia — see baracorne Smart.
dicerops Pomeroy (apud Edwards 1934).
beckeri Roubaud (apud Edwards 1934).
annulipes Becker (apud Bequaert 1938).
diversipes Edwards (apud Bequaert 1938).
rufidorsum Enderlein (1934a : 283) Psilopelxma Neotropical.
ruffidorsuin Enderlein: (1936b : 119) Acropogon — see costaricensis Smart.
rupicolum Seguy & Dorier (1936 : 1) Europe.
rutherfoordi Meillon (1937 : 397) Simulium Ethiopia.
caracoriensis Gibbins (1934 : 63) Simulium — see dentalosum Roubaud.
salopiense Edwards (1927c : 255) Simulium Europe.
salopiense tagarum Rubtzov.
samboni Jennings (1915 : 199) Simulium Neotropical.
sanguinarius Pallas (1771 : 475) Bibio (see notes) Volga.
sanguineum Knab (1915b : 279) Simulium Neotropical.
saritc Baranov (1936 : 262, 274) Odagmia ornata form — see ornata Meigen.
sayi Dyar & Shannon (1927 : 40) Simulium Neartic.
shirgi Rubtzov (1940 : 368 & 509) Simulium (Odagmia) — see alecensis Rubtzov.
schielii Enderlein (1926 : 141) Cnetha Europe.
schonenmanni Enderlein (1934a : 277) Acropogon Neotropical.
schonbaueri Enderlein, (1921a : 200 & 1921b : 218) Simulium Europe.
seutellatum Lane & Porto (1941 : 192) Simulium Neotropical.
seuttiria Lutz (1909 : 133) Simulium Neotropical.
sencat Baranov (1926 : 192), Nevermannia aurea — see aureum Fries.
sencat Baranov (1926 : 186), Wilhelmia equina — see equina Linnaeus.
sencat Baranov (1926 : 189), Odagmia ornata — see ornata Meigen.
sencat Baranov (1926 : 191), Odagmia ruficorne — see ruficorne Baranov.
sencat Baranov (1926 : 185), Wilhelmia stylata — see stylata Baranov.
senilis Brunetti (1911 : 288) Simulium Oriental.
servicium Baranov (1925 : 9) Nevermannia — see bertesti Enderlein.
serratum Knab (1914b : 81) Simulium Neotropical.
serrata Meigen (1838 : 310), Simulium (see notes) — see erythrocephalum Degge.
sereca Linnaeus (1767 : 978) Tipula (see notes) Europe.
seriens Meillon (1944 : 119) Simulium hirsutum var. — see hirsutum Pomeroy.
shirakii Kono & Takahasi (1940 : 82) Simulium mirum Shiraki (apud Kono & Takahasi 1940), Japan.
sicuani Smart (1944b : 132) Simulium Neotropical.
limbata Enderlein (apud Smart 1944b).
incitunicum Vargas.
simile Silva Figueroa (1917 : 33) Simulium — see figueroa Smart.
similis Malloch (1919 : 42c) Simulium — see icticicum Malloch.
similis Rubtzov (1940a : 196) Simulium Simulium — see rubzovi Smart.
sinajj Enderlein (1924b : 286) Odagmia — see ornata Meigen.
simplicolor Lutz (1910 : 251) Simulium Neotropical.
helecticolor Lutz (apud Knab 1911).
Dr. John Smart on the classification

sinensis Enderlein (1934a : 287) Boophthora China.
slossonae Dyar & Shannon (1927 : 34) Simulium Neartic.
spadicidorsum Enderlein (1934b : 194) Trichodagmia Neotropic.
speculifrons Enderlein (1921a : 200 and 1921b : 217) Odagmia—see variegatum Meigen.
speculiventre Enderlein (1914 : 374) Simulium Seychelles.
spinifera Knab (1914b : 81) Simulium Neotropic.
spendidum Rubtsov (1940 : 423 & 517) Simulium (Simulium) East Siberia.
stenel Stains & Knowlton (1943 : 277) Simulium Neartic.
striatum Brunetti (1913 : 90) Simulium Oriental.
stiistriatum Senior-White (apud Puri 1932).
strigata Enderlein (1934a : 290) Trichodagmia Neotropic.
strigidorsum Enderlein (1934a : 279) Acropogon Neotropic.
strigonotum Enderlein (1934a : 284) Thyaspelma Neotropic.
stylata Baranov (1926 : 185) Wilhelmia (see notes) Europe.
stylata prima Baranov (1926 : 185).
stylata secunda Baranov (1926 : 185).
subexci us Edwards (1915 : 41) Simulium Palearctic.
subfasciata Meigen (1838 : 54) Simulium Europe.
submorsitans Rubtsov (1940 : 435 & 519) Simulium (Simulium)—see annum Rubtsov.
submorsitans Seguy (1921 : 294) Simulium Canary Isles.
subornatum Edwards (1920 : 227) Simulium—see nolleri Friederichs.
subpusillum Rubtsov (1940 : 404 & 505) Simulium (Schönbaueria) Palearctic.
subvariegatum Rubtsov (1940 : 439) Simulium (Simulium) East Siberia.
tanacetipennis Townsend (1897 : 171) Simulium—see occidentale Townsend.
tangae Smart (1944b : 132) Simulium Ethiopian.
timbatum Enderlein (apud Smart 1944b).
tarsale Williston (1896 : 253) Simulium Lesser Antilles.
tarsatum Malloch (apud Smart 1942).
tarsatum Philippi (1865 : 634) Simulium—see philippianus Pinto.
taylori Gibbins (1938 : 21) Simulium Ethiopian.
tentaculum Gibbins (1936 : 223) Simulium Ethiopian.
tenuifrons Enderlein (1921a : 200 & 1921b : 222) Simulium Europe.
tenuifrons Enderlein (1936b : 130) Odagmia—see diaz-najeri Vargas.
tenuimanus Enderlein (1921a : 200 & 1921b : 222) Simulium—see nolleri Friederichs.
tenuipes Knab (1914a : 17) Simulium Neotropic.
tenuitaris Puri (1933b : 809) Simulium Oriental.
tenuitaris Baranov (1936 : 264, 276) Odagmia Europe—see baranovi Smart.
tephrades Speiser (1904 : 148) Simulium Mexico.
terribilis Förster (1891 : 167) Simulium Fossil.
ter tus Baranov (1926 : 186), Wilhelmia optima—see optima Linnaeus.
tisiphone Meillon (1936 : 210) Simulium—see elgonensis Gibbins.
ijibodense Edwards (1934 : 134), Simulium latipes var.—see latipes Meigen.
tonniri Drummond (1933 : 6) Simulium Australian.
tosariense Edwards (1934 : 132), Simulium latipes var.—see latipes Meigen.
touffeum Gibbins (1937a : 292) Simulium Ethiopian.
townsendi Malloch (1912 : 651) Simulium Neartic.
transbaikaleicum Rubtsov (1940 : 403 & 504) Simulium (Schönbaueria) East Siberia.
transcaspicum Enderlein (1921b : 223) Simulium Europe.
tribulatum Lugger (1896 : 205) Simulium—see vittatum Zetterstedt.
trisphaeme Wanson & Henrard (1944 : 40) Simulium griseicolle var.—see griseicolle Becker.
tristrigata Enderlein (1921a : 200 & 1921b : 213) Nevermannia—see bezzi Corti.
trivittatum Malloch (1914 : 30) Simulium Neartic.
distinctum Malloch.
transcauda Lundström (1911 : 13), Melusina reptans var.—see reptans Linnaeus.
tuberossum Lundström (1911 : 14) Melusina Palearctic.
jenneri Enderlein (apud Rubtsov 1940),
valgus Durogiastajskij, Rubtsov & Vlasenko (apud Rubtsov 1940).
var. vulgaris (O., R. & V. of Rubtsov (1940 : 421)).
var. palure Rubtsov.
tubulibranchium Lutz (1922 : 92) Simulium—see botulibranchium Lutz.
turgidum Rubtsov (1940 : 411 & 507) Simulium (Wilhelmina) salopicense—see salopicense Edwards.
turgidum Hoffmann (1930b : 298) Eusimulium—see mexicanum Bellardi.
turnale Twinn (1938 : 51) Simulium—see vandalicum Dyar & Shannon.
turneri Gibbins (1938 : 22) Simulium Ethiopian.
twinni Stains & Knowlton (1940 : 77) Simulium Neartic.
twinni Stains & Knowlton (1940 : 88) Simulium—see medusaformis Pomeroy.
twinned Stains & Knowlton (1940 : 79) Simulium Ethiopian.
urubambanum Enderlein (1934a : 286) Simulium Neotropic.
ussarianum Rubtsov (1940 : 354 & 501) Simulium (Nevermannia) maculatum—see maculatum Meigen.
var. vulgaris Knowlton & Rowe (1934 : 582) Eusimulium—see aureum Fries.
vandalicum Dyar & Shannon (1927 : 44) Simulium Neartic.
turnale Twinn (apud Stains & Knowlton 1943).
var. vulgaris Knowlton & Rowe (1934 : 582) Eusimulium—see aureum Fries.
vandaic Hamburger (1923 : 159) Simulium Oriental.
variegata Meigen (1818 : 292) Simulium (see notes) Palearctic.
var. varia Meigen (1818 : 292) Simulium (see notes) Palearctic.
livida Schellenberg (apud Meigen 1818).
affinis Stephens (apud Edwards 1915).
luteicornis Stephens (apud Edwards 1915).
venifica Friederichs (apud Edwards 1920).
specularifrons Enderlein (apud Rubtsov 1940).
varipes Philippi (1865 : 634) Simulium Neotropic.
velfistshvili Rubtsov (1940 : 413) Simulium (Wilhelmina) Central Asia.
venator Dyar & Shannon (1927 : 36) Simulium—see meddiovittatum Knab.
venifica Friederichs (1920a : 219 & 1921 : 172) Simulium—see variegatum Meigen.
venustoides Hart in Forbes (1915 : 42) Simulium—see decorum Walker.
venustum Say (1823 : 28) Simulium (see notes) Holartic.
molestum Harris (apud Coquillett 1898).
piscicidium Riley (apud Coquillett 1888).
austeni Edwards (apud Edwards 1920).
minutum Lugger (apud Washburn 1905).
irritatum Lugger (apud Washburn 1905).
rileyana Enderlein (apud Dyar & Shannon 1927).
aukuroae Matsumura (apud Kono & Takahasi 1940).
venustum karatschatum Rubtsov.
vernion Macquart (1826 : 79) Simulium (see notes)—see ornatum Meigen.
vestita Enderlein (1929a : 74) Cnetha Europe.
violaceens Enderlein (1934a : 285) Simulium Neotropical.
violaceum Enderlein (1922 : 75) Simulium Europe.
violaceum Pomeroy (1922 : 450) Simulium alcocki var.—see impudica Meillon.
virgatum Coquillett (1903 : 97) Simulium Nearctic, Neotropical.
virolatum Chiperenense Hoffmann (apud Bequaert 1934).
virgatum rubicundulum Knab (apud Dyar & Shannon 1927).
hippovorum Malloch (apud Dyar & Shannon 1927).
vittata Zetterstedt (1938 : 802) Simulium Holartic.
tribulatum Lugger (apud Dyar & Shannon 1927).

Notes.

Index to Notes.

affinis, 14.
angustipes, 6g, 8d.
angustitarsis, 4b, 5g, 6g, 8c.
anulatum, 6c.
argenteostriata, 6c.
argyreatum, 2d, 3a, 5d, 6d, e.
argyropezaum, 1d, 2b, 3b.

ater, 1c, 10.
averum, 2d, 3d, 4b, 5g, h, 6g, 8b, d, 14.
avericornu, 2d, 3d, 5f, 6a.
candum, 2b, 3h.
cinerum, 6f, 8b.
columbaceiensis, 1c, 2b, 3b, e, 5b, 8b, 11.
columbacezensis, 2f, 3b, e, 11.
of the Simuliidae (Diptera).

of Ihe Simuliidae (Diptera).

1. Meigen (1818) gives a certain amount of synonymy. This has been carried down through the literature to the catalogues of Kertész (1902) and Becker et al. (1903) and thence into current literature. The process can be traced in the notes below. The other early piece of synonymy that gave rise to much difficulty was Latreille's statement (1804) that *colombaschensis* Fabr. and *reptans* L. were synonymous (this has been considered at page 478).

According to Meigen:

(a) *ornatum* Mg. (syn. *regulationis* L. of Mg. (1803)).

(b) *reptans* L. (syns. *reptans* niger Fabr., *erythrocephalum* Deg.).

(c) *maculatum* Mg. (syns. *cólmobaschensis* ater Fabr., *pungens* Panz.).

(d) *sericeum* Linn. (syns. *argyropeza* Mg.).

2. Schiner (1864) in the second vol. of his *Fauna Austriaca* gives some synonymy in which he largely follows Zetterstedt (1850), etc. According to him:

(a) *ornatum* Mg. (syns. *regulationis* L. of Mg., *sericatum* Mg.).

(b) *reptans* L. (syns. *sericatum* Mg., *erythrocephalum* Deg., *colombachensis* Fabr. (sic), *argyropeza* Mg., *elegans* Mg., *variegatum* Mg., *cincta* Mg., *posticatum* Mg.).

(c) *argyreatum* Mg. (syns. *nana* Zett.).

(d) *latipes* Mg. (syns. *auricoma* Mg., *auricom* Fries).

(e) *maculatum* Mg. (syns. *pungens* Mg. in Panz., *marginatum* Mg., *lineatum* Mg., *pubicentrum* Mg., *fuscescens* Fries, *pygmaea* Zett.).

(f) *colombachensis* Schönbl. (sic; no syns.).

(g) *hirtipes* Fries (syns. *hirtipes* Fries of Mg., *rusipes* Mg.).

3. Kertész (1902) and Becker et al. (1903) in their comprehensive catalogues give certain synonymies that differ radically from those given in the catalogue.
above. Their conclusions must all have been based on the earlier literature and not on any intimate knowledge of the Simuliidae or acquaintance with the types. They give:

(a) *argyreatum* Mg. (syn. nanum Zett.).
(b) *columbaczense* Schönb. (*columbascensis* Fabr. = *maculatum* Mg. q.v.).
(c) *hirtipes* Fries (syn. *rugeipes* Mg.).
(d) *latipes* Mg. (syns. *auricum* Mg., *auricoma* Fries).
(f) *equinum* L.
(g) *ornatum* Mg. (syns. *regulationis* L. of Mg. (1803), *sericatum* L. of Mg.).

4. Enderlein at various dates has given synonymies, drawn attention to alleged misidentifications, etc. Since there is no evidence in his papers that these findings are based on a careful study of the types of authors, especially of the older authors, all these have not been incorporated in the catalogue. Some of these which might interest workers on the Simuliidae are listed below:

(a) According to Enderlein (1930, etc.):
   - *lineatum* Mg. (syn. *stylata* Bar.).
   - *equinum* L. (no syns.).

(b) i. According to Enderlein (1921a : 200):

ii. According to Enderlein (1921b):
   - *Wilhelmina falcata* End. (misspelt *falcata*) (syn. *angustitarsis* Lund. of Edw. (1921) apparently error for (1920)).


v. *angustitarsis* Lund. applies to Lundström’s female only, the male being in fact *aureum* Fries as above.

vi. Enderlein (1922 : 69) removed *aureum* Fries from *Nevermannia* to *Cnetha*.

vii. Later Enderlein (1930) repeated the syn. in i. above, but while he continued to catalogue the name *falcata* as a valid species he did not repeat the syn. of it. He placed *angustitarsis* Lund., *lundstromi* End. and *aureum* Fries in *Cnetha*; *falcata* End. and *lineata* Mg. in *Wilhelmina*.

(c) i. According to Enderlein (1921a and c):

ii. According to Enderlein (1930):
   - *Asfega yerburyi* Edw.
   - *Cnetha annulus* Lund.
   - *Cnetha costata* Fried. (? = var. of *annulus*).

(d) According to Enderlein (1925):
According to Enderlein (1925, etc.):

i. **hirtipes** Fries (syns. *tömösvaryi* End., *fuscipes* Roser) (and see note 12).

ii. **nigripes** End. (syn. *hirtipes* Fries of Edw.).

iii. According to Smart (1944b):


iv. It will be found in the preceding catalogue that Edwards' identification is regarded as valid and consequently *tömösvaryi* End. (syn. *hirtipes* Fries of Enderlein) is given as a valid species.

v. The whole question of the identity of the holarctic *hirtipes* requires investigation.

According to Enderlein (1934a):

i. **lutzianus** End. (syn. *venustum* Say of Latz) and omits reference to *pertinax* Kollar.

ii. According to Enderlein (1936b):

    *lutzianus* End., *pertinax* Kollar and *distinctum* Lutz are all distinct species of *Trichodagmia* End.

5. Friederichs (1919, 1920 and 1921) dealt with certain European species. Since, in his earlier papers, he made some misidentifications, it is important to see the last paper if making an examination of his work.

According to Friederichs (1921):

(a) **ornatum** Mg. (syns. *regulationis* L. of Mg., *reptans* L. of Lundström (in part), *reptans* L. of Fried. (1919) (in part)).

(b) **ornatum pratorum** Fried. (syn. ? *varium* Mg.).

(c) **ornatum nitidifrons** Edw. (syn. *reptans* L. of Fried. (1920)).

(d) **argyreatum** Mg. (syn. *varium* Zett. (after Kertész)).

(e) **reptans** L. (syn. *pectum* Mg. of Fried. (1920)).

(f) **auricoma** Mg. (syn. *latipes* Mg. of Schiner).

(g) **aurcum** Fries (syn. *angustitarsis* Lund. of Edw.).


(b) **ornatum nitidifrons** Edw. (syns. *reptans* L. of End. and of Fried.).

(c) **variegatum** Mg. (syns. *varium* Mg., *ornatum var. b. Zett.).

(d) **reptans** L. (syns. *elegans* Mg., *postica* Mg., *nana* Zett., ? *argyreatum* Mg., *reptans* var. rostrata Lund.).


(g) **angustitarsis** Lund. (syns. ? *latipes* Mg. of Edw. (1915), ? *angustipes* Edw. (in part), *aurcum* Fries of Edwards (1915)).
7. According to Edwards in Edwards, Oldroyd and Smart (1939):—

pallipes Fries (syn. ?trecuccinatum Edw.).

8. According to Dorogostajski, Rubtsov & Vlasenko (1935):—

(a) reptans L. (syns. elephas Mg., sericeum L., variim Zett., pictum Fried.).
(b) equinum L. (syns. colombaschensis Fabric., aureum Fries, marginatum Mg.,

maculatum Mg., lineatum Mg., pubicentrum Zett., pubescens Meq., cinnereum

Meq., maculatum Mg. of Schiner, and of Grünberg, aureum Lund.,

stilbata Bar., maculata Mg. of End.).
(c) latipes Mg. (syns. fusipes Fries, angustihoradis Lund. of Fried., costatum

Fried.).
(d) aureum Fries (syns. latipes Mg. of Kertész, angustipes Edw.).

9. The identity of ochraceum Walker is uncertain. The species identified as ochraceum Walker by various authors are not all the same.

10. Linnaeus's Fauna Suecica of 1746 has no standing in zoological nomenclature, since it ante-dates the tenth edition of the Syst. Nat. (1758). In it Linnaeus used the two latinised names Culex niger and Culex ater. In the tenth edition of the Syst. Nat. he indicated that these two were respectively his Culex reptans and Culex equinum. While the names Culex niger and Culex ater have no status in zoological nomenclature, it is as well to mention them in a catalogue because they have appeared in latinised form in some of the older works (e.g. Fabricius) and from the context in which they are cited it is not always absolutely clear that they are without nomenclatural status.

11. The original description of Bibio sanguinarius Pallas reads:—


Fabricius (1787: 333) gave sanguinarius as a synonym of colombaschensis when he described the latter as a new species. This must, however, have been pure conjecture on his part. Schönbauer (1795) regarded colombaschensis Fabricius and sanguinarius Pallas as distinct from his colombaschenses. sanguinarius is quite unrecognisable from the description, though the details of the act of biting certainly point to a species of Simulium.

As far as the present author has been able to discover, no authors subsequent to Fabricius (1787) have claimed to identify sanguinarius; Fabricius himself omits the name in works following that of 1787. It is omitted from the catalogues of Kertész (1902) and Becker et al. (1903).

12. The present author has not been able to consult the original description of fusipes Roser. The species is catalogued as a distinct species by Kertész (1902: 287) and Becker et al. (1903: 157), fusipes Fries being given by these authors as a synonym of maculatum Meigen. Enderlein (1922: 76) regarded fusipes Roser as a valid species and placed his own tünścargi Enderlein (1921) as a synonym thereof. Enderlein (1925: 202) placed both fusipes Roser and tünścargi Enderlein as synonyms of hirtipes Fries. There are doubts about the identification of hirtipes Fries—see note 4e. Enderlein does not mention fusipes Fries in any place as far as the present author can discover.

Without reference to the original paper it is not clear whether fusipes
Roser is a new species or the species which Roser identified as fusiceps Fries. In the meantime the species can be recognised and named thomasiwargyi Enderlein.

13. Culex lanio Linnaeus (1771 : 541) was omitted from the catalogues of Kertész (1902) and Becker et al. (1903). Edwards (1924 : 34) recognised it as a species of Simulium. The description is too brief to allow the species to be positively identified.

14. Stephens (1829) published four names of new species of Simulium in a catalogue but gave no descriptions. These names were thus nominum nuda. Edwards (1915) having Stephens' specimens before him gave all four of these names as synonyms of other British species of Simulium. According to Opinion 4, Note 4, of the International Commission on Zoological Nomenclature (1944) these names are without any status from 1829 till Edwards' act of identifying the species in 1915. It thus comes about that affinis Meunier (1907) is not, as Smart (1944b : 133) erroneously thought, preoccupied by affinis Stephens since the validity of this latter name dates only from 1915. On the other hand fluviipes Austen (1921 : 116) (= jerichousis Smart) is preoccupied by fluviipes Stephens (Edwards 1915) (= auricuam Fries). The two others are luteicornis Stephens (= variata Meigen) and piceipes Stephens (= hilaripes Fries).

V. Summary.

Attention is drawn to the difficulties that have arisen in the classification of the Simulidae owing to the contemporary but divergent classifications proposed by Edwards and Enderlein.

The earlier classifications proposed for the family are outlined and the work of Enderlein and Edwards examined in some detail.

Proposals for the classification of the family are made.

The various segregates of this proposed classification are considered one by one and the characteristics of each enumerated. In addition the genus Simulium sensu lato et antico of authors is considered.

A key to the proposed genera is given.

A catalogue of the described species of Simulidae, classified in accordance with the classification proposed in this paper, is presented.

VI. References.

The following are the papers referred to in various places in preceding pages of the present paper. The list does not constitute a bibliography of the literature on the Simulidae but it is probably a fairly complete list of papers dealing with the family's taxonomy.

Pomeroy (1916) published a very useful bibliography which is particularly useful to those interested in the biology of the Simulidae and to workers on North American species. Wilhelmi (1921) published a long bibliography obviously intended to be exhaustive but containing some errors and a few omissions. Wilhelmi & Saling (1928) published a bibliography supplementary to that of Wilhelmi. These last two bibliographies are invaluable to the student of the Simulidae and in particular those of Europe when considered as a veterinary problem. Bequaert (1934) gave a bibliography of selected titles, stressing particularly the medical importance of the family; it is a most useful introduction to a study of the family.

There is no detailed monograph of the group; Smart (1944c) has given an
outline introduction to the morphology, biology, etc., of the flies and the early stages with particular reference to the British species; Rubtzov (1940) has summarised our knowledge of the family in greater detail but his paper is in Russian; Vargas (1945) has given a shorter summary in Spanish.

——, 1926b, N. Beitr. syst. Insektenk. 3: 183-94.
——, 1925, Arch. Tierheilk. 72: 158-64.
BLANCHARD, E., 1852, in Gay, C., Historia fisica e politica de Chile (Zool.) 7: 353.
BRODIE, P. B., 1845, A History of Fossil Insects: 33, 121.
——, 1912, Fauna of British India, Diptera 1: 182-95.
——, 1913, Spol. Zeylan. 8: 90-1.
COLLIN, J. E., 1942, Ent. mon. Mag. 78: 97-103.
CURTIS, J., 1839, British Entomology 16: 765.
——, see Enderlein, G., 1924a.
DEGREER, C., 1776, Mémoires pour servir à l'Histoire des Insectes 6: 431.
——, 1920, Bull. ent. Res. 11: 211-16.
of the Simuliidae (Diptera).

EDWARDS, F. W., 1924a, Ent. Tidstr. 45: 29-34.
—, 1925, Treubia 6: 154-72.
—, 1928, J. F. M. S. Mus. 14: 1-139.
—, 1931, Diptera of Patagonia and South Chile 2 (1): 121-54.


FARRMICHOL, J. C., 1781, Species Insectorum 2: 470.
—, 1787, Mantissa Insectorum 2: 335.
—, 1794, Entomologicae Systematice 4: 276.
—, 1805, Systema Antliatorum : 55-6.


FIGUEROA, C. S., see Silva Figuero, C., 1917.

FORBES, S. A., see Hart, C. A., 1912.

FÖRFER, B., 1891, Abh. Geol. Spezialk Eis. 3: 467.

FRIEDRITCHEs, K., 1919, Z. angew. Ent. 6: 61-83.
—, 1921, Z. angew. Ent. 8: 31-92.
524 Dr. John Smart on the classification

Gay, C., see Blanchard, E., 1852.
Geer, C. de, see Degeer, C.
—, 1914b, Bull. ent. Res. 6: 279-82.
Kollar, V., see Pohl, J. E., 1832.
Kölliker, R. A., see Bremer, F., 1812.
—, 1943, Rec. ent. 14: 139-40.
—, 1758, Systema Naturae (ed. 10) 1: 581-607.
Loew, H., 1771, Mant. Plant. 2: 541.
—, 1810b, Passerar Zoölogiae : 3.
—, 1810b, Isis von Oken 1840: 514.
Dr. John Smart on the classification

—, 1926, Parasitology 18: 100-7.
—, 1932g, Ind. J. med. Res. 20: 803-12.


Rondani, C., see Philippi, R. A., 1863.


—, see Dorogostajski, V., et al., 1935.


—, 1868, Reise Novara Zoal. 2: 1-388.


—, 1925c, Eos, ent. (B) (Dipt.) 2 (1): 1-6.
—, 1925d, Eos 1: 231-8.


Sherborn, C. D., 1923, Index Animalium Pt. 3: 539.
—, 1933, Index Animalium Pt. 33: 559.


of the Simulidae (Diptera). 527


— —, 1945a, Rev. Inst. Salubridad y Enfermedades trop. 5 : 37-41.


Westwood, J. O., 1840, Synopsis Genera, Classification of Insects 2 : 129.


— —, 1855, Diptera Scandinavica 12 : 4831.

TRANS. R. ENT. SOC. LOND. 95. PART 8. (DEC. 1945.)
ADDENDUM.

When the above paper was submitted for publication Rubtzov's (1910) volume was not available to me, Vargas' (1945) book had not been published and only a trickle of war-time European literature was reaching the libraries. Since then these two works and a limited amount of the war-time European literature have become available for examination. It has thus come about that while every endeavour has been made to make the catalogue up-to-date—it is hoped that it contains all names published up to and including 1945—a few war-time names, particularly if published in Europe, may have escaped notice.

Two new names in Simuliidae are here proposed, the need for them having become apparent while this paper was in proof and at a date when prior publication elsewhere could not be assured.

Simulium rubtzovi nom. nov. pro Simulium (Simulium) similis Rubtzov (1941 : 196) preoc. Simulium similis Malloch (1919 : 42) and Simulium similis Silva Figueroa (1917 : 33).

Simulium baranovi nom. nov. pro Simulium tenellivarses (Baranov) preoc. Simulium tenellivarses Puri (1933b : 809).

Apart from these two, no new names, specific or generic, are proposed in this paper.

14 December, 1945.
PUBLICATIONS

The Publications of the Royal Entomological Society are Transactions and Proceedings.
The Transactions form an annual volume, each paper in the volume being issued as a separate part. The parts are issued irregularly throughout the year.
The Proceedings are issued in three series:

Series A. General Entomology
Series B. Taxonomy
Series C. Journal of Meetings

Series A and B are issued in twelve parts, forming an annual volume of approximately 240 pages.
The following information is supplied for the guidance of authors wishing to submit papers for publication in any of the Society's journals.

INTRODUCTORY

The Society is prepared to undertake the provision of a reasonable number of text figures. The original drawings for such figures must be supplied by authors. Such drawings or groups of drawings must be drawn to a scale which will permit of their reduction to an area of dimensions not exceeding $7\frac{1}{4} \times 4\frac{3}{8}$. In the case of the Proceedings Series A and Series B, authors are required to pay for the necessary blocks for the provision of plates, half-tone and coloured work.

A uniform method is adopted for the citation of bibliographical references in the Society's publications as follows:


Titles of periodicals cited are to be abbreviated in the manner indicated in the World List of Scientific Periodicals, 2nd edition, 1934.

Authors are entitled to receive 25 copies of their papers free of charge and may purchase additional copies provided that request be made before publication.

Papers offered for publication should be sent to the Secretary, Royal Entomological Society of London, at 41, Queen's Gate, London, S.W.7, and must be typewritten on one side of the paper only. Sufficient space must also be left between the lines for editorial corrections.

The copyright of the Society's publications is vested in the Society.

TRANSACTIONS

Papers offered for publication in the Transactions are considered by the Publication Committee of the Society, which meets usually in the months of May and November. In order that papers may be considered at these meetings it is necessary for the manuscript and drawings for any illustrations to be in the hands of the Secretary fourteen days before the meeting of the Committee.

Papers of less than eight printed pages (approximately 7000 words) will not normally be accepted for the Transactions, and papers by authors who are not Fellows of the Society must be communicated by a Fellow.

PROCEEDINGS SERIES A AND SERIES B

Papers submitted for publication in either Series A or Series B of the Proceedings by authors who are not Fellows of the Society may be accepted if they are communicated by a Fellow. Preference will be given to papers written in the English language, and papers of more than eight printed pages (7000 words) will not normally be accepted for publication in these journals.

PROCEEDINGS SERIES C

Series C is issued prior to every General Meeting. It contains abstracts of exhibits to be shown and communications to be made, together with the titles of papers accepted for publication.

The annual subscription to Series A, General Entomology is £2 os. od.; Series B, Taxonomy, £2 os. od. (single parts 4s. od.); and Series C, Journal of Meetings, 6s. od.

As from January 1936 the journal Stylops is continued as Proceedings Series B, Taxonomy. Copies of volumes 1–4 are available at £1 16s. od. each, post free.
MEETINGS
TO BE HELD IN THE SOCIETY’S ROOMS
41, Queen's Gate, S.W.7

1946.

WEDNESDAY, January 16 (ANNUAL MEETING)
February 6

THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

The Fellowship and Fees

Fellows pay an Admission Fee of £3 3s. The Annual Contribution of £2 2s. is due on the first day of January in each year, and is payable in advance. Fellows under the age of 25 years may pay the entrance fee in three equal annual instalments. Fees should be paid to the Treasurer, at 41, Queen's Gate, S.W.7, and not to the Secretary.

Fellows desiring to pay their Annual Contribution through their bankers may obtain an official form of banker's order by applying to the Treasurer.

Fellows whose Contributions for the current year have been paid are entitled to receive the Transactions and Proceedings of the Society free of charge. Further copies may be purchased at reduced prices by applying to the Registrar.

Forms of application for Fellowship, copies of the Bye-Laws and the List of Fellows may be obtained from the Registrar.

Meetings and Exhibitions

Fellows and others wishing to make a communication to a General Meeting of the Society are requested to send in their names, the title of their exhibit, and a short abstract of their remarks, to the Registrar fourteen days before the meeting at which it is proposed to make the communication. Should it be desirable to publish a fuller account of the communication the manuscript may be submitted for publication in Proceedings Series A or Series B. If the epidiascope is required, 24 hours' notice must be given. Objects for projections should not exceed 6 ins. by 6 ins.

Fellows resident abroad, or otherwise unable to attend meetings, are reminded that notes or observations sent to the Secretary may be communicated to a General Meeting on their behalf.

PRINTED FOR THE SOCIETY BY RICHARD CLAY AND COMPANY, LTD.,
BUNGAY, SUFFOLK.

JOHN SMART, Ph.D.

REPRINTED FROM THE
ANNALS OF TROPICAL MEDICINE AND PARASITOLOGY
Vol. 29, No. 2, July 17, 1985

ISSUED BY
THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE

THE UNIVERSITY PRESS OF LIVERPOOL
THE INTERNAL ANATOMY OF THE BLACK-FLY, SIMULIUM ORNATUM MG.

BY

JOHN SMART, Ph.D.

(Carnegie Research Scholar, Department of Zoology, University of Edinburgh)

(Received for publication 20 March, 1935)

CONTENTS

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>161</td>
</tr>
<tr>
<td>General</td>
<td>162</td>
</tr>
<tr>
<td>The mouth-parts</td>
<td>163</td>
</tr>
<tr>
<td>The salivary glands</td>
<td>164</td>
</tr>
<tr>
<td>The alimentary canal</td>
<td>165</td>
</tr>
<tr>
<td>The reproductive system (female)</td>
<td>166</td>
</tr>
<tr>
<td>Other internal organs</td>
<td>167</td>
</tr>
<tr>
<td>The anatomy of the male fly</td>
<td>168</td>
</tr>
<tr>
<td>Summary</td>
<td>169</td>
</tr>
<tr>
<td>References</td>
<td>169</td>
</tr>
</tbody>
</table>

INTRODUCTION

A survey of the relevant literature reveals the fact that, except for a somewhat inadequate paper of Hungerford (1913), there is no detailed account of the internal anatomy of any single species of the family Simuliidae. That this deficiency should be made good is desirable in view of Blacklock's (1926) discovery of the rôle played by the African Simulium damnosum in the transmission of Onchocerca volvulus from one human host to another, and of the subsequent demonstration by Hoffmann (1930) of the transmission of O. caeculints by S. mooseri. The transmission of Leucocytozoon anatis, a haemogregarine of domestic and wild ducks, by S. venustum reported by O'Roke (1934), which suggests that Simuliids may play a rôle in the transmission of protozoan blood parasites, is an additional reason for presenting the description of the internal organs of a black-fly.

S. ornatum does not normally attack man, but it has been recorded as attacking domestic animals by Steward (1932) and by Edwards (1929). However, comparison of its internal structure with that of S. hirtipes, S. venustum, S. pictipes and S. monticola reveals few differences, and the first two species are well-known 'blood-suckers' in North America.

Specimens of S. ornatum were readily accessible to the writer, and it was felt that a description of the internal anatomy of this species would be serviceable and would be found to correspond with that of other members of the family.

Where the feeding habits of the Simuliidae are known, only the females are recorded as 'blood-suckers.' Little is known of the feeding habits of the males, except that (1) they do not suck blood; (2) their mouth-parts are of the same general conformation as those of the female, but much weaker; (3) they are occasionally found at rest on the inflorescences of shrubs, such as willows,
and in other similar situations. Arguing from these facts and from analogous cases in other blood-sucking Diptera, it is usually stated that the male Simulids are 'nectar feeders.' Internally the difference in the anatomy of the two sexes is slight, except as regards the reproductive systems. In view of the unimportance of the male as a possible vector, it is proposed in the present paper to describe more fully the internal organs of the female, and subsequently to note the main differences between those of the two sexes.

GENERAL

Females of *S. ornatum* are about 5 mm. in length when freshly emerged from the pupa and unfed. A few exceed this length by 1 mm., while starvation will produce individuals as small as 2.5 mm. Feeding and development of the gonads result in an increase in the size of the abdomen, the integument of which is weakly chitinized except for the tergites of the last three segments.

![Semi-diagrammatic section of unfed female *S. ornatum*, to show the relations of the internal organs.](image)

Abbreviations (applicable to figures): AMN—abdominal ganglion; AN—anus; ANT—antenna; ASG—accessory gland; COL—colon; DFR—duct of food reservoir; FB—fat-body; FR—food reservoir; HT—heart; HYP—hypopharynx; IL—ileum; LBN—labium; LB—labrum; MGT—mid-gut; MT—Malpighian tubule; NC—nerve cord; OES—oesophagus; OG—optic ganglion; OP—oesophageal pump; OT—ovary; PFR—pharynx; PRO—proventriculus; RC—rectum; RP—rectal papillae; SD—salivary duct; SG—salivary gland; SOG—sub-oesophageal ganglion; SP—salivary pump; SPTH—spermatheca; SR—salivary reservoir; SUG—supra-oesophageal ganglion; TGN—thoracic ganglion; V.G—vagina.

The general configuration of the fly can be seen in fig. 1, which is a somewhat diagrammatic sagittal section of an unfed female to show the relations of the various organs to each other and to the different regions of the body itself.

The mouth-parts are of the laterally-cutting type described by Jobling (1928) in *Culicoides*, and the oral aperture leads to a highly chitinized pharynx. The pharynx leads to the chitinized oesophageal pump, and thence the soft-walled oesophagus passes through the neck and expands slightly. From the floor of this expansion passes the duct of the ventral diverticulum, which itself lies in the antero-ventral part of the abdomen. Immediately posterior to the
expansion of the oesophagus is the oesophageal valve or proventriculus. The mid-gut extends from the proventriculus in the anterior part of the thorax to the fifth abdominal segment. It is a straight tubular structure divisible into a narrower anterior portion in the thorax and an expanded posterior portion in the abdomen, the latter being capable of considerable distension by food.

At the junction of the mid-gut and the hind-gut are four Malpighian tubules. The anterior two-thirds of the hind-gut are in the form of a narrow, slightly convoluted tube; this passes into the expanded rectum, in which are six rectal papillae.

The ovaries are paired structures with a single spermatheca and a pair of accessory glands. The heart, nervous system and fat-body do not call for special mention. The salivary glands are situated in the anterior part of the thorax dorsal to the oesophagus.

THE MOUTH-PARTS

The mouth-parts of various species of Simuliidae have been figured and described by several authors, among whom may be mentioned Smith (1890), Emery (1913) and Cameron (1922). No attempt appears to have been made to determine the relationships of the various parts till Jobling (1928) showed that the mouth-parts of S. ornatum were arranged similarly to those of Culicoides. Examination in detail of the mouth-parts of S. ornatum and other Simuliid species has enabled me to corroborate Jobling's opinion, while observations made on living specimens of S. hirtipes demonstrated that the mode of biting was essentially the same as that of Culicoides.

![Diagram of mouth-parts](image-url)

Fig. 2. The mouth-parts of the female of S. ornatum. A.—Labium, ventral view (× 130); B.—Hypopharynx, dorsal view (× 130); C.—Labrum epipharynx, dorsal view (× 130); D.—Right maxilla, dorsal view (× 130); E.—Right mandible, dorsal view (× 130); F.—Right maxilla and palp (× 57).
The various parts are shown in fig. 2. The labrum epipharynx (fig. 2, C) is a pointed, membranous structure, strengthened and kept rigid by three heavy, rod-like, surface chitinizations. At the tip are two heavily chitinized trifid teeth. The outer edges of the labrum are smooth.

The theca of the labium (fig. 2, A) appears to consist of two separate bilaterally symmetrical parts; but actually these are fused at their bases, and only the labella are completely separate from each other. Proximally, the labella are stiffly chitinized, but distally they are soft and have numerous sensory hairs on their surfaces. They are capable of slight distension, and their extremities curve round and forward and almost meet in front of the labrum. When biting, the distal extremities of the labella surround the labrum and other mouthparts which are slowly inserted into the skin of the host, embraced and guided by the labella.

The hypopharynx (fig. 2, B) is a flat spatulate structure with a fringe of anteriorly directed bristles on its anterior margin. It is strengthened by various chitinizations shown in the figure; the salivary duct opens about half-way down its length. It is not completely free from the labium, but is connected to it by a loose, sac-like, membranous structure lying between the proximal joints of the labella. Ventrally, within the sac-like structure, the hypopharynx has a keel-like ridge (fig. 4, hyp.), up which the salivary duct (sd.) passes.

The mandibles (fig. 2, E) are thin, flat structures. Their articulations are external to the outer margins of the labrum and the hypopharynx, but they are shaped in such a way as to have the greater part of their blades lying one on top of the other between the labrum and the hypopharynx. Their anterior margins are dentate and there are minute striations running up the blade from the marginal teeth. In the centre of the blade of each mandible is a clear depressed area similar to that found in Culicoides by Jobling (1928).

The maxillae (fig. 2, D) are somewhat lanceolate in shape when viewed from the dorsal (anterior) aspect. They are round in section, though this is modified distally where the anterior face is flattened, the retrorse teeth, with which it is armed, being set around this flattened part. The maxillae lie along the outer margins of the labrum and the hypopharynx. The palps (fig. 2, F) are four-segmented, though the first basal segment has the appearance of being the product of fusion of two, but it is quite rigid. The second segment bears a depressed flask-like sensory vesicle, which opens to the exterior.

THE SALIVARY GLANDS

The paired salivary glands (fig. 4, sg.) lie in the antero-dorsal region of the thorax (fig. 1, sg.). They consist of two parts, a distal, elongated, secretory portion consisting of large vacuolated cells, bent on itself in the form of a U, and a rounded reservoir (sr.) composed of smaller cells and from which passes the narrow salivary duct (sd.). The salivary ducts from the two glands pass down
on each side of the gut and the nerve cord, and unite beneath the latter. From the point of junction, the common salivary duct expands, and its walls are strengthened with rib-like chitinizations, the whole forming the salivary pump

(s.p.) which has been described by Nitzulescu (1927). Anteriorly, the common duct narrows and passes up the keel-like ridge on the ventral surface of the hypopharynx to open on the centre of its upper surface.
THE ALIMENTARY CANAL

From the mouth, which may be defined as the opening bounded by the bases of the epipharynx and the hypopharynx, the alimentary canal passes to the densely chitinized pharynx (phr.) and oesophagus. The pharynx is in the form of a broad tube with the dorsal wall invaginated, giving the whole a U-shape in traverse section (fig. 6). The ventral wall is densely chitinized, the dorsal one less so. Strong muscles are inserted in the dorsal wall. The anterior part of the oesophagus forms the oesophageal pump (op.) and is strongly chitinized, save at its immediate junction with the pharynx where it is membranous, thus permitting a certain flexibility of the joint. The oesophageal pump is triangular in section (fig. 5), and consists of two ventro-lateral chitinized plates and one dorsal chitinized plate. The pump is operated by muscles inserted on the plates, which are themselves elastic. The remainder of the oesophagus is thin-walled and passes into the thorax, where its walls thicken, and the lumen expands slightly before it joins the mid-gut in the oesophageal valve or proventriculus (fig. 4, pro., and fig. 7).

On the floor of the oesophageal expansion mentioned above is the opening of the duct of the single median oesophageal diverticulum or food reservoir (fr.). The walls of the duct are very thin and collapsed, so as almost to obscure its lumen. The diverticulum itself (fr.) lies in the antero-ventral region of the abdomen below the mid-gut and above the nerve cord. In figures 1 and 3 the crop is shown in an empty and collapsed state; it is, however, capable of considerable distension, and it has a fine irregular muscular meshwork on its walls.

The oesophageal valve or proventriculus (fig. 7) of the adult Simulid is much simpler than that of the larva. Histologically, except for somewhat ill-defined differences in the shape and size of the component cells and the complete absence of a striated margin in the cells, the component tissues of the proventriculus are similar to those of the anterior portion of the mid-gut proper. No peritrophic membrane has been found in any of the species examined, and consequently in its absence the sole function of the valve would appear to be the prevention of the regurgitation of food. It does not act as an elaborate press for the production of the peritrophic membrane as in the larva, as remarked by Strickland (1913), Puri (1925) and Smart (1934).

The mid-gut extends from the proventriculus in the thorax to the fifth abdominal segment as a straight tube of varying diameter. The anterior half is narrow, while the posterior half is expanded to a degree that varies with the condition of the fly; the expanded portion narrows posteriorly to join the hind-gut. The walls of the mid-gut have circular and longitudinal muscle-bands arranged in a fine but distinct rectangular meshwork. The epithelium of the anterior region of the mid-gut (fig. 8) is columnar, modified by being thrown into irregular folds. The depth of these folds is very variable among different specimens; in some it is hardly noticeable; in others it is marked. The epithelium of the posterior region (fig. 9) is also variable in thickness; it may
be as thick as that of the anterior region, or, when the gut is distended, it may be about a quarter of the thickness shown in fig. 9; it is usually without folds. The entire epithelium of the mid-gut has a striated margin, which is thicker in the anterior region.

The four Malpighian tubules enter the hind-gut at its junction with the mid-gut, in two lateral pairs, each pair having a common duct for entry. The tubules are approximately one-and-a-half times the length of the abdomen. The cells of the tubules are large with opaque granular contents and a large clear nucleus. The individual cells expand between the junctions with their neighbours, giving the tubule a coarse moniliform appearance, except at the basal end where the cells are smaller. A slight constriction of the gut occurs both above and below the openings of the Malpighian tubules.

The anterior two-thirds of the hind-gut (figs. 1 and 3, il. and col.) are tubular and slightly twisted. The twist, however, disappears later when the abdomen elongates as the result of the development of the ovaries. The posterior third of the hind-gut is expanded into a flask-shaped rectum (rect.) containing six rectal papillae, which project into the cavity and are arranged in a circle around the opening of the colon. The rectum narrows as the alimentary canal proceeds to the anus (an.), which is situated at the tip of the slightly recurved abdomen.

THE REPRODUCTIVE SYSTEM (FEMALE)

The ovaries (figs. 1 and 10) are of a similar type to those of *Chironomus* described by Miall and Hammond (1900). They consist of a large number of

---

**Fig. 10.** The internal genitalia of the unfed female *S. ornatum*, dorsal view. (*× 52.*)

**Fig. 11.** Genital fork of female *S. ornatum*. (*× 52.*)

**Fig. 12.** The internal genitalia of the male *S. ornatum*. (*× 52.*)

*ED.*—ejaculatory duct; *ES.*—ejaculatory sac; *GF.*—genital fork; *GVD.*—glandular part of the vas deferens; *OVD.*—oviduct; *TST.*—testis; *VD.*—vas deferens.
short ovarioles radiating from a central axis, the whole surrounded by a thin membrane. The figures show the ovaries of recently emerged and unfed females. As they mature, the ovaries grow till they occupy practically the entire cavity of the abdomen, which becomes considerably distended with their growth. The oviducts at the bases of the ovaries are very short and membranous; they lead to the vagina (vag.).

The vagina is flattened in the horizontal plane, its walls are muscular and there is a chitinous supporting rod (gf.) in the dorsal wall. This supporting rod is part of the 'genital fork' (fig. 11), which is an ingrowth of the cuticle at the external opening of the vagina, where it bifurcates into two arms which are continuous with the external cuticle. There is a single brown chitinous spermatheca (spth.), which lies dorsal to the vagina. Close to the spermatheca are a pair of accessory glands (asg.), whose ducts, along with that of the spermatheca, open to the exterior between the two arms of the genital fork.

Growth of the ovary, as noted above, leads to a considerable increase in size. The egg, when laid, is ·30 mm. by ·17 mm. by ·16 mm. and is triangulate in shape. In the fully developed ovaries of the ovipositing female most of the space is occupied by fully developed eggs. Microscopic examination, however, reveals the presence of immature ova, a finding which lends support to the conclusions of Pomeroy (1916) and Cameron (1922) that a second oviposition is probable.

The genital armature consists of two simple lateral flaps.

**OTHER INTERNAL ORGANS**

Other internal organs do not show any special peculiarities requiring mention. The heart lies in the position indicated in fig. 1 (ht.). The fat-body is scattered throughout the abdominal cavity; it decreases in bulk as the ovaries develop. The central nervous system (cnvs.) consists of oesophageal ganglia, three thoracic ganglia and five abdominal ganglia.

**THE ANATOMY OF THE MALE FLY**

Except for the reproductive system, the various organs of the male fly differ but little from those of the female. The mouth-parts are slightly smaller and much weaker. The same parts are present as in the female, but the maxillae and mandibles are reduced to pointed stylets, armed with bristles instead of teeth, and they would appear to be useless as a cutting mechanism. The salivary glands are smaller than those of the female but otherwise similar. The gut exhibits no differences; the Malpighian tubules are not as large as those of the female. Heart, fat-body and nervous system are as in the female.

The testes (fig. 12, tst.) are pyriform bodies lying dorso-laterally to the gut. They are invested with a brown fibrous sheath which is continuous with that of the vasa deferentia (vdf.). The vasa pass round the gut and, ventral to it, become suddenly expanded and fuse together (ged.). This fusion is external
only, and the lumina of the vasa remain distinct. The walls of the expanded portion of the vasa are glandular, of the type demonstrated in some other Diptera by Keuchenius (1913); they perform the functions of accessory glands which are absent. The expanded parts of the vasa are differentiated into two portions; distally there is a rounded chamber into which the narrow parts of the vasa enter, the walls of which are less glandular than those of the proximal portions. The separate lumina unite to form a short ejaculatory duct (ed.) leading to an ejaculatory sac (es.), and thence to the external genital opening with its complicated copulatory armature.

Acknowledgments

The main part of the investigation was carried out in the Department of Zoology at the University of Edinburgh while the writer was holder of a Carnegie Research Scholarship. The writer’s thanks are due to Professor J. H. Ashworth and Dr. A. E. Cameron, of Edinburgh, for their kind advice and help. Some preliminary observations and all those connected with the living flies were carried out while the writer was holder of a Research Scholarship from the Department of Agriculture for Scotland, studying at the New York State College of Agriculture at Cornell University, Ithaca, N.Y., U.S.A.; the writer is indebted to Professor R. Matheson for his help at that time.

SUMMARY

The paper consists of a brief description of the internal organs of the female Simuliid as found in S. ornatum Mg. The general arrangement is very similar to that found in allied Diptera. The anatomy of the male fly resembles that of the female. Examination of specimens of four other species of Simulium shows that they resemble S. ornatum in the essentials of their internal organization.

REFERENCES


EDITORIAL NOTICE

Articles for publication should not exceed twenty-five pages of the Annals, and will be understood to be offered alone to this Journal. They should be typewritten and addressed to:

The Editors
School of Tropical Medicine
Pembroke Place
Liverpool, 3.

Illustrations for text figures or charts should be drawn clearly and firmly in Indian ink, if possible on Bristol board. N.B.—Blue or other coloured ruling in squares or lines cannot be reproduced.

All lettering, names or legends on text-figures, charts or maps should be printed sufficiently large to allow of clear legibility on reduction if necessary.

Plates and illustrations should be accompanied by short explanations.

References to authors in the text must be made in the following way:

According to Smith (1900) the spleen is enlarged, but Robinson (1914) says the reverse. The references should be collected in alphabetical order of authors’ surnames at the end of the paper, and arranged in the following way:


Twenty-five reprints are supplied of each paper, free of charge. Additional copies (up to 100) can be supplied at cost price. Further supplies of reprints can be obtained by special arrangement.

Subscription: £1 2s. 6d. per volume, post free, payable in advance to The University Press of Liverpool, 177, Brownlow Hill, Liverpool, 3, to whom correspondence concerning advertisements should also be addressed.

Printed in Great Britain by H. R. Grubb, Ltd., Croydon.
FRESHWATER
BIOLOGICAL ASSOCIATION
OF THE
BRITISH EMPIRE

Scientific Publication No. 9

THE BRITISH SIMULIIDÆ
With Keys to the Species in the
Adult, Pupal and Larval stages
by
JOHN SMART, Ph.D.
Dept. of Entomology, British Museum (Nat. Hist.)

Price to non-members 2s. 6d.
1944
Scientific Publications

(Nos. 1 to 6 & No. 8 post free 1/7 each, Nos. 7 & 9 post free 2/7).
No. 1. A key to the British Species of Corixidae (Hemiptera-Heteroptera) with notes on their distribution, by T. T. Macan.
No. 2. A key to the British Species of Plecoptera (Stoneflies) with notes on their ecology, by H. B. N. Hynes.
No. 3. The Food of Coarse Fish, by P. H. T. Hartley.
No. 4. A key to the British Water Bugs (Hemiptera-Heteroptera excluding Corixidae) with notes on their ecology, by T. T. Macan.
No. 5. A key to the British Species of Freshwater Cladocera, with notes on their ecology, by D. J. Scourfield and J. P. Harding.
No. 7. Keys to the British Species of Ephemeroptera, with keys to the genera of the nymphs, by D. E. Kimmins.
No. 8. Keys to the British Species of Aquatic Megaloptera and Neuroptera, by D. E. Kimmins.
No. 9. The British Simuliidæ, with Keys to the Species in the Adult, Pupal and Larval stages, by John Smart.

Annual Reports

summarise the scientific work undertaken in each year.
Nos. 1-6 (some out of print, post free 1/2 each).
Nos. 7-12, for the years 1939 to 1944 (post free 1/8 each).

Results of Research

are published in scientific journals. A limited number of reprints is available to members on request.

MEMBERSHIP.

Membership, which includes free publications, the right to work at the Laboratories, etc., is open to any who wish to give their support to the Association, the minimum annual subscription being £1 0s. 0d.

All communications concerning publications and membership should be addressed to the Director (Dr. E. B. Worthington).
THE BRITISH SIMULIIDÆ
WITH KEYS TO THE SPECIES IN THE ADULT, PUPAL AND LARVAL STAGES
17 figures in the text.
by JOHN SMART, Ph.D.
Dept. of Entomology, British Museum (Nat. Hist.).

CONTENTS.

<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>KEY TO THE SUB-GENERA AND SPECIES (IMAGINES)</td>
<td>32</td>
</tr>
<tr>
<td>KEY TO THE SPECIES (PUPAE)</td>
<td>38</td>
</tr>
<tr>
<td>KEY TO THE SPECIES (COCOONS)</td>
<td>44</td>
</tr>
<tr>
<td>KEY TO THE SPECIES (LARVAE)</td>
<td>46</td>
</tr>
<tr>
<td>NOTES ON ECOLOGY AND DISTRIBUTION</td>
<td>50</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>54</td>
</tr>
</tbody>
</table>

INTRODUCTION.

a. The Family Simuliidae (Diptera).

The Simuliidae are a very homogeneous and discrete family of Nematocerous Diptera. They are obviously more closely allied to the Chironomidae, Ceratopogonidae and Culicidae (families not represented in the British fauna are excluded from consideration here) than to the other families of the Nematocera, but even amongst these families they stand by themselves cut off from the others by a variety of distinctive characters at all the stages of their life-history.

The habit, possessed by the females of many species, of attacking man and domestic animals, inserting their mouth-parts and sucking up blood, has brought them into prominence both owing to the nuisance caused by the bites—many of the biting species occur at times in vast numbers—and the proven fact that some species act as vectors of certain pathogenic organisms. It has been demonstrated
that certain Simuliidae transmit species of *Onchocerca*, a nematode worm that affects man and domestic animals, and *Leucocytozoon anatis*, a protozoan blood-parasite of ducks in America. The species of *Onchocerca* that affect man do not occur in the British Isles, but *O. gutturosa*, which is found in the brisket of cattle, causing no great harm there, has been shown by Steward (1937) to be transmitted by *Simulium ornatum* in England.

The Simuliidae are cosmopolitan in their distribution. In some places abroad the nuisance caused by their bites at particular seasons of the year prevents man entering certain districts while in others it may put a stop to the cultivation of the fields, it being impossible to expose the draught animals—quite apart from their driver—to the pain and discomfort of their mass-attacks. In the British Isles their attacks are commonly attributed to the 'Midges' though this term should be restricted to species of *Culicoides* (Diptera, family Ceratopogonidae), and the name 'Black-Fly' (not to be confused with the same name given to the black aphid of the bean) applied to the adults of species of the family Simuliidae. The American name 'Buffalo Gnat' refers to the hump-backed appearance of Simuliidae and a fancied resemblance on this account to the American Bison. In these islands their attacks seldom amount to more than a nuisance and whether this is regarded as severe or not will largely depend on the sensitivity of the individual. Their continued attacks on cattle and horses cause these animals great irritation and, quite apart from the loss of blood, such animals are often forced to seek shelter from the flies at times when they should be feeding or resting, and in consequence they will not thrive and put on weight as they should. It is probable that the loss incurred in this way is very considerable in certain districts where a vicious biting species is particularly prevalent. In other parts of the world, deaths of men and of domestic animals have been attributed to the effects of their bites. Their habit of flying round one's head before biting can be extremely irritating and curiously enough this habit is indulged in by species which do not actually bite man.

The larval and pupal stages are entirely aquatic. The fact that they present many interesting morphological features that are obviously adaptations to their watery environment has drawn considerable attention to these early stages. Since, however, they are
found in running and often torrential waters and never in still water
the collector of the early stages is faced with some difficulties,
occasionally even dangers, and those who aspire to rear young larvæ
to the adult stage have problems of technique to contend with that
are usually outside the scope of laboratories not equipped with
compressed air on tap and other facilities for work with the less
adaptable forms of aquatic life. These early stages have been taken
from the stomachs of fish and are thus of some interest as fish-food.

b. General Remarks.

Prior to 1915 our knowledge of the British species of Simuliidæ
was scanty and consisted almost solely of records of species, lists
and a few descriptions. Many of the determinations were erroneous.
There was no paper to which one who would study the group could
turn as a starting point for further work. The knowledge of the
European species was in much the same plight until Lundström
(1911) published his study of the Finnish species.

Fortunately the British species attracted the attention of the
late Dr. F. W. Edwards and he (1915) published a paper in which
he gave keys to the adult males and adult females with notes on the
species and their distribution and a series of figures of the male
genitalia. Later Edwards (1920) published a second paper in which
he did a similar service for the larvæ and pupæ. Both these papers
were founded on Dr. Edward’s personal field work.

Puri (1925) published an excellent paper on the larval and
pupal stages. He had access to most of the material that Edwards
had worked with and was obviously in close touch with Edwards
throughout the execution of his work.

Recently Edwards (1939) published further notes on the species
and gave a key to the female adults.

With these four excellent papers available the present writer’s
task has been one of compilation. There is plenty of literature on
the Continental species but unless the student of the group is desirous
of prosecuting his studies of that literature to a considerable extent
he will be best advised to leave it alone; a few leading titles in this
literature are given in the references.
c. **Structure.**

No complete detailed description of the morphology of the imago of any single species of Simuliidae has been published. There are numerous non-detailed accounts, frequently with extended descriptions of some particular part. The worker in the British Isles will probably find it easiest to refer to Gibbins (1935) for the structure of the male genitalia; Gibbins (1938) for the structure of the mouth-parts; and Smart (1935) for the internal anatomy and notes on mouth-parts. In the case of the larvae and pupa the adequate and well illustrated account of Puri (1925) has already been mentioned.

i. **THE ADULTS** of the British species of Simuliidae range from 2 to 7 mm. in length (fig. 1). Their bodies are rather plump compared with those of other families of Nematocera and this, with
Fig. 2  The heads of (a.) a female and (b.) a male of a species of Simulium. Both are viewed from in front. The tips of the mandibles can be seen in the female but nothing can be seen of them in the male. Note the difference in the size of the compound eyes; the line of demarcation between large upper facets and the smaller lower facets of the male eye is indicated by a broken line. $\times 40$. (Original.)
the relatively short legs and antennae, renders the term 'gnat,' frequently applied to many Nematocera, inapplicable to them. In the females the abdomen is capable of very considerable distension to accommodate a meal of blood or other food and later to allow for the development of the ovaries.

The head is relatively large (figs. 2a, b); in the females nearly as broad as the thorax, in the males as broad and sometimes a trifle broader. The antennae are relatively short, the individual segments, of which there are eleven, being cylindrical in shape and close set to each other; they have short hairs upon them but no whorls of hairs such as are found in many other Nematocera. The mouth-parts of the female, which are constructed to cut and pierce the skin of the host upon which they feed, are relatively short; on either side depends a four-segmented palp, much longer than the mouth-parts themselves, of about the same length as the antennae. The mouth-parts of the male are similar but weaker and incapable of biting like those of the female. There are no ocelli.

The compound eyes of the female are kidney shaped. The strip of the head capsule between the eyes and above the antennae is spoken of as the front while that below the antennae is called the face. The facets of which the surface of the eye is composed do not differ much in size from one part of the surface to another in the female.

The compound eyes of the male cover a much larger part of the surface of the head than do those of the female. They meet in the middle line and thus, for practical purposes, obliterate much of the front. The facets of the upper part of each eye are much larger than those of the lower part and, moreover, the line of demarcation between the upper area of large facets and the lower one of small facets is very distinct. Specimens are most easily sexed by noting the condition of the compound eyes.

The thorax is somewhat humped and of sturdy appearance. The pattern of the dorsum or dorsal surface will frequently have to be examined in order to make specific determinations (figs. 12a, b). This pattern is often one that changes considerably according to the incidence of the light. It is difficult to describe these changing patterns. When the dorsum is being examined for its pattern the
whole insect should be moved about in the light till it seems certain that the pattern described does or does not occur. The dorsum of the thorax, and other parts of the body may bear hairs or hair-like scales; the presence or absence of these, their size and colour may be of importance. On the side of the thorax is a very obvious membranous area; it is most easily seen in newly killed specimens.

Fig. 3 The wing of *Simulium (Prosimulium) hirtipes* Fries with the venation labelled; somewhat diagrammatic. × 25. (Original.)

The wings are large and broad, the veins toward the forward edge are thickened and conspicuous while the remainder are very weakly marked; cross-veins are all toward the base of the wing (fig. 3). The vein which runs along the front edge of the wing is called the costa (C). This vein is clothed with macrotrichia. In one British species, *hirtipes*, these macrotrichia are all of a simple fine bristle-like structure; in the other species (i.e., those not belonging to the sub-genus *Prosimulium*) there is a mixture of fine bristle-like macrotrichia and stouter spine-like ones (fig. 4). The sub-costa (Sc) is the longitudinal vein immediately behind the costa running parallel to it till it turns forward and runs into the costa about halfway between the wing base and the wing-tip. There is little to note about the sub-costa beyond the fact that it lies at the bottom of a fold of the wing membrane (viewed from above) and consequently
is most easily seen when the wing is viewed from the under-side. Posterior to the sub-costa there is a series of veins running out from the wing base towards the wing margin. The student of the British species of Simuliidæ need only remember the names and situations of the basal sector of the radius ($R_1$), the radial sector ($R_5$) and the position of the basal cell; the other veins exhibit features of interest to the student interested in the systematics of the family as a whole but they do not aid in the identification of the British species. The basal sector of radius is clothed on the upper side with a few sparse hairs in some species, while in others (sub-genus Simulium) it is bare above. The radius must be noted in order to locate accurately the radial sector so that it may be decided if the latter vein is forked, as it is in hirtipes, or simple, unforked, as it is in all other British species. In two British species (hirtipes and tredecimatun) (sub-genera Prosimulium and Cnephia) the basal cell is present while in the others it is absent.

The legs exhibit characters which are of use in distinguishing the various species. The most important structural characters are those of the hind-leg. The hind-leg consists, as do the other legs, of the various segments or parts usually found in the normal insect leg, viz. the coxa attached to the thorax and, passing outward from the coxa, the small trochanter, the elongate femora, the elongate tibia and then the five segments of the tarsus the last of which bears the claws which constitute the foot. The first tarsal segment, th
one next the tibia, is termed the *metatarsus* or *basitarsus*. The basitarsus is elongate in shape but not as long as the tibia. In shape it may be cylindrical or slightly swollen, spindle-shaped, according to the species. A feature is the presence or absence of a small flap that is, in some species, developed on the inner side of the apex of the basitarsus (fig. 5). This flap has been called the *calcipala*

---

*Fig. 5* A portion of the tarsus of the hind leg of a female *Simulium ornatum* Mg., magnified to show the calcipala on the apical end of the basitarsus (or metatarsus) and the pedisulcus on the second tarsal segment. (Original.)

(by Enderlein 1930) and the name is now generally accepted. The calcipala is completely absent in one British species (*hirtipes*) but in some of the others it is rather small and indistinct and in these its presence might be overlooked; it is consequently not a reliable character to use in such species as have the calcipala only moderately developed. The next segment of the tarsus, the *second tarsal segment* is shorter still though longer than its own diameter. In the majority of the British species there is an indentation or notch on the upper side of this segment called the *pedisulcus* (by Enderlein), (fig. 5). This is completely absent in two species (*hirtipes* and *tredecimatum*); it takes the form of a rather shallow indentation in two species (*subexcisum* and *yerburyi*), while in the remaining species it is notched. The calcipala and the pedisulcus are both features that can only be seen properly when the specimen is examined under a binocular microscope with a magnification of at least ×24. It is better still to mount the leg in balsam on a slide and examine it under the monocular microscope. This last method has the advantage that the exact outline of the tarsal segments can be seen much more clearly than in the dry unmounted limb where the vestiture of hairs often obscures the details of the shape of the segment beneath.
The remaining three tarsal segments do not present any features of use in determining the identity of the various species. There is a bilateral expansion of the fourth tarsal segment to form pad-like structures which appear to be used, with the claws, in holding on to the substratum. The claws may be simple: may have a tooth on them; may have a curious basal thumb-like process; and may show marked differences in size and shape. All these features are useful in certain cases for deciding or confirming the specific identity of specimens but they can only be appreciated when they are looked at under the higher powers of the binocular microscope or the monocular microscope.

The fore- and mid-legs consist of the same series of segments as the hind legs but there is no calcipala on the basitarsus and no pedisulcus on the second tarsal segments. In some species the tarsi, and the basitarsus in particular, are more or less expanded vertically and compressed laterally while in others they are cylindrical.

The coloration of all the legs differs very considerably from species to species and consequently is frequently used to discriminate between them.

The abdomen in itself provides few characters useful for the specific determination of the British species except of course in the males where the external genitalia exhibit valuable features. The tergite of the first segment in both sexes is developed into a very characteristic basal "abdominal scale"; it is flattened and fringed with hairs and it is rather difficult to be certain that it is part of the abdomen and not part of the thorax. The general surface of the abdomen is matt but in some species the upper surfaces of the segments behind the fifth segment are shiny in contrast to the matt surface of the anteriorly situated segments.

The external genitalia of both sexes are situated beneath the tip of the abdomen.

The male-gentialia are found to be, as in so many groups of the Diptera, of great value in separating species (fig. 6). To examine them properly they must be snipped off the tip of the abdomen and prepared as a slide mount for examination under the microscope. In practice, however, familiarity with material will eventually make it possible at least to make preliminary examinations of the male
The genitalia of the male Simulium ornatum Mg. (a) the whole viewed from beneath with the parts labelled, (b) the phallosome dissected and viewed from the side. (Original.)

While specific characters have been found by various

The names given to the parts in the figure are those adopted by Edwards (1931) and de Meillon in their recent papers. This nomenclature differs in detail from that proposed by Gibbins (1935). The main differences are that in Gibbins' terminology the parameral hooks, the aedeagus and the phallosome are respectively called the posterior phallosome, median phallosome and anterior phallosome. The term adminiculum has frequently been applied to the phallosome and aedeagus taken together.
authors in practically all the constituent parts of the terminalia, the discrimination of the British species can be effected on the characters of the clasper and the coxite alone without reference to such parts as the phallosome which is partly within the body and usually difficult to observe without going to a considerable amount of trouble and carrying out fine dissections.

The female-genitalia present characters which some writers have used to distinguish species of Simuliidae from one another. The British (and European) species have not been studied yet in this respect. Fig. 7 shows the structure of the parts and the terminology applied to them.

![Diagram of female genitalia](image)

**Fig. 7** The genitalia of the female *Simulium ornatum* Mg. partially dissected and spread out, viewed from beneath with the parts labelled. (Original.)

ii. THE PUPÆ of the British species of Simuliidae range from about 3 to 5.5 mm. in length (fig. 8a). When the last larval skin has just been cast the pupa is quite pallid but it rapidly assumes a light- and then a dark-brown coloration. As it matures the colour becomes almost black but just before the eclosion of the adult fly a silveryness appears due to the accumulation of gas (?air) between the dark adult within and the transparent pupal skin (see under...
Life History, below p. 22). The most prominent feature of the pupa is the possession of a pair of respiratory organs (fig. 8b) which spring from the antero-dorso-lateral region of the thorax. The pupa is obtectate and lies in a cocoon spun by the larva before the act of pupation (fig. 15).

Fig. 8  The pupa of Simulium (Prosimulium) hirtipes Fries: (a.) viewed from the side with the respiratory organs cut short × 16; (b.) the respiratory organ alone. × 24. (The figures were prepared from specimens from Keltney Burn, near Fortingal, Perthshire, Scotland.) (Original.)
The head is closely appressed to the thorax. When the pupae are approaching maturity it is possible to sex them by noting whether the developing adult within possesses the large holoptic eyes of the male or the smaller dichoptic eyes of the female; this is easily seen through the semi-transparent pupal skin. There are a few small hairs on the pupal integument.

The thorax, like that of the adult, is humped. A few small hairs, or trichomes, occur upon it; these are simple in all except one of the British species. The wings and legs lie, closely packed, ventral to the thorax and the anterior part of the abdomen. The appearance of the respiratory organs can best be appreciated by looking at the figures. In two British species they consist of thin walled finger- or horn-like colourless structures (fig. 14); in the others they are well chitinised long slightly tapering tube-like branching filaments (fig. 8b). In one species there are 16 (and perhaps more) final branches but in the others, apart from one species with 11—14 final branches, there are exactly 8, 6 or 4 branches, except in rare abnormal specimens. In most cases it is possible to determine the species to which a pupa belongs by examination of the pupal respiratory organs alone.

The general configuration of the cocoons may be seen by looking at fig. 15. They may be described as “shoe-shaped” when the opening is raised from the substratum (fig. 15e); “slipper-shaped” when there is no “heel” to raise the opening from the substratum (fig. 15a, b). In one British species (*hirtipes*) the shape is irregular and no definite opening is made.

iii. The larva of the British species of Simuliidae range up to 10 mm. in length. Their appearance may be seen in fig. 9. The well chitinised head is clearly distinguishable from the rest of the body; the body is somewhat indistinctly segmented. The head of a larva that has just moulted is colourless and the internal parts can be viewed through the transparent cuticle. The head capsule rapidly darkens, however, and may be quite black eventually. The body acquires its colour from a layer of pigmented cells beneath the thin transparent chitinous cuticle; the colour varies from a pallid translucent white to dark brown (black in some non-British
Fig. 9  The mature larva of *Simulium ornatum* Mg. labelled to show the various parts. × 18. (Original.) The structure labelled respiratory filament above has been called the respiratory organ in the text.
species) but it is fairly constant in each species. When the gut is filled with food, as it almost always is in freshly captured specimens, the nature of the gut contents may add something to the general impression of the colour of the larva. The whole body is transparent and the organs can be seen within. When dead and pickled in alcohol or other medium the whole becomes opaque and the general colour rather white.

The head is remarkable for the pair of mouth-brushes which are articulated to the antero-lateral region. These mouth-brushes consist of a fan-like series of rays that can be extended or closed up articulating on a stout stalk. The antennae lie just behind and a little above the bases of the mouth-brushes. They are small, inconspicuous, tapered and consist of four segments. Some of these segments may exhibit secondary annulations which are constant in the different species. The mouth-parts consist of a pair of maxillae with maxillary palps; a pair of mandibles; and a median labium with a conspicuous strongly chitinised submentum or mental plate. The mandibles possess features that are characteristic of the different species but since their examination entails dissection of the head and mounting the mandible for examination under the microscope, they will not be considered here (see Puri (1925) for figures of the mandibles). The submentum also presents specific characteristics: these can be made out without the destruction of the specimen with the aid of a low power microscope, they are not, however, used in the keys now presented except in one couplet (see Puri (1925) for figures of the submenta). On either side of the head are the larval eyes.

The most important features of the head for the determination of the species to which larvae belong, are the ornamentation and pigmentation of the head-capsule itself. The ornamentation consists of little disc-like marks on the surface of the capsule which are aggregated into groups the arrangements of which are constant in the different species. These discs occur on the dorsal and lateral surfaces of the head-capsule. Differences in the depth of the pigmentation of the chitin of the head-capsule produce patterns that are different in different species. Reference to fig. 17 will show how these vary from species to species: the pattern made by the
differences in pigmentation should be considered along with the ornamentation due to the groups of discs. Some small hairs will be found on the surface of the head-capsule.

The body may be considered as a whole. It is rather like an attenuated flask in shape and consists of three thoracic segments and eight abdominal segments. On the ventral surface of the first thoracic segment there is a median anteriorly directed pro-leg. This limb is in the shape of a truncate cone and it bears re-curved hooks, arranged in radial rows, on its tip. At the hind end of the body, on the eighth abdominal segment is a ring, interrupted mid-dorsally and mid-ventrally, of radially arranged rows of outwardly directed hooks. This ring of hooks, often called the “posterior sucker,” is used by the larva to attach itself to the sub-stratum when it is stationary. The anus is situated on the top of the eighth segment above the “posterior sucker.” On either side are patches of minute rectal scales. Some species have a ventral papilla2 (fig. 16c) on either side of the end of its body, below the anus. The anal gills are a protrusable trifid structure that can be thrust out of the anus as required. The three parts may be simple finger-like structures or they may be branched; the structure is constant in any particular species.

On the sides of the thoracic segments of all except the younger larve there are to be seen, beneath the skin, the imaginal buds of the adult legs and wings and pupal respiratory organs. These are white at all stages of growth except the respiratory filaments which become dark brown or almost black as the time for pupation approaches. It is possible to dissect out the imaginal buds of the respiratory filaments when in this blackened condition and examine the characters thereof. Some small hairs will be found on the general surface of the body.

All the important larval characters can be seen in the cast skin after a moult has taken place. Sometimes such skins—of the last larval stage—will be found sticking to the pupa or the cocoon.

2The term “ventral papilla” is that used by Puri (1925). These papillae are really lateral in position but their extremities are directed ventrally. To avoid confusion Puri’s nomenclature is followed here.
iv. THE EGG, in those species in which it is known, is ovoid in shape with a bulge on one side that gives it an ovoid-triangular appearance when viewed along its shortest axis (fig. 10). It is about 3 mm. long. When newly laid the egg is whitish yellow but the shell soon assumes a light brown colour and later the developing larva within causes the general colouration to change to dark brown or even black.

![Fig. 10 Egg of Simulium. (Original.)](image)

d. Life History.

The larvæ and pupæ of the Simuliidae (with the exception of one African species found on lake shores) are always found in the moving waters of rivers, streams, canals, etc. They are usually associated with the more rapidly flowing streams where they are often found in great numbers at the particular spots where the conditions suit them best. They are, however, also to be found in the more sluggish waters including those of the large navigable rivers where they may be much more sparsely distributed although probably occurring in equally large numbers when the extent of the habitat is taken into consideration. Different species prefer different types of streams. In Britain, hirtipes is only known from small streams in the Scottish Highlands where the water is found cascading from one stone to another; the larvæ of this species are usually found upon the upper surfaces of such stones over which the water is actually cascading, they are never beneath a horizontal water surface. Usually ornatum, variegatum and reptans are found in streams where the flow is fast and the water broken on the surface into ripples, but not passing over cataracts or cascading. Huge numbers of equinum are often found on the water-weeds of larger rivers where there is a strong steady flow. Generally latipes occurs
in small ditches where the flow of water dries up completely in the
summer-time. If a river of any size passing through different types
of country be followed down from its source a succession in the
species of *Simulium* will be discovered (e.g. Pentelow (1935) River
Test; Smart (1936) Perthshire streams).

The egg-laying habits of only a few of the British species of
*Simulium* are known. In some species the eggs are laid under
water, the female deliberately submerging herself to reach the site
of oviposition. In other species the eggs are laid on the leaves of
water plants that are trailing on the surface of the water and the
weight of the eggs and the fact that they are wetable causes the leaf
to sink into the water and submerge the eggs. In others it would
appear that the eggs are usually laid in a place where a rise in the
level of the stream will wet them and at a time when there is a good
chance of this happening. As far as it is known the eggs of *Simulium*
cannot survive dessication. There is, however, a possibility that
those of *latipes* and *aureum* and perhaps others may do so but complete
proof is wanting (Edwards 1920).

The eggs are laid in masses. Always in some species, sometimes
in others, the masses are individual ones, each female making one
mass. Communal masses to which many females contribute their
eggs are the usual habit in other species. The oviposition habits of
*hirtipes* are unknown, but such negative information as exists suggests
that this species may not lay its eggs in masses at all (Smart 1936).

The incubation period of the egg varies with the temperature
of the stream; under normal conditions in the stream it probably
ranges from three days to a week. Information on the incubation
period is scanty and if the eggs of any species can resist dessication
then it is probable that such eggs will have a much prolonged
incubation period.

The young larva within the egg-shell is furnished with an egg-
burster on the top of its head. When the egg-shell splits open the
larva comes out head first. The young larva then floats away from
the egg mass on the end of a silk thread that it spins from its salivary
glands and which it has attached to some point on or near the egg
mass before releasing its hold on the substratum. Eventually it
reaches some point suitable for it to settle down on.
Most of the British species probably pass through more than one generation in the course of the year; all over-winter in the larval stage though in some a few adults and pupae may be found late in the autumn and very early in spring: hirtipes is known to be exceptional in that it has only one generation in the year. Simulium hirtipes must pass some 10—11 months in the larval stage unless of course, the incubation period of the (unknown) egg is prolonged. In the other species the over-wintering larvae persist for up to six or seven months while the larva from which the summer adults develop must mature in one or two months or perhaps less.

The larva passes through several stages as it grows up. There are six or perhaps more of these stages; between each the larva moults. In all stages the mode of life is the same.

The normal position for the larva is stationary attached to the substratum by means of the "posterior sucker." The larva spin silk threads to form a web on the substratum, which gives the hooks of the "posterior sucker" something to grip. Larvae appear to make webs every time they move and so the substratum occupied by a thriving colony of the larvae becomes covered with a communal web. The "posterior sucker" is slightly sub-terminal and, since the larva live in a current, the body tends to be tilted toward the substratum. Thus the mouth and the mouth-brushes would face toward the substratum. To collect food the larva twists itself round through 180° till the mouth-parts face the passing water and the mouth-brushes, when opened up, stick out into the current. The torsion through 180° is a gradual twisting throughout the whole abdomen.

Feeding is accomplished by catching particles in the passing current with the mouth-brushes. These are then brought down to the mouth-parts and consumed or rejected. The larva will also pick food up from the substratum but this is probably an adaption to starvation conditions in the laboratory. The larva in some species at any rate do not seem to be very selective in their feeding. Vegetable debris, animal debris, algae, are all taken and cannibalism has been noted, large larva eating small ones. It is more than likely that the limitation of what is eaten is a matter of size rather than quality; small pieces of grit have been found in the gut-content.
The larvæ may move over the substratum. This they do with a looping motion. The head is brought down with the body extended and a small web of silk made on the substratum. This web is then gripped by the proleg and by the mouth-parts, the “posterior sucker” releases its hold and is brought forward and affixed to the new web close to the proleg. The mouth-parts and the proleg release their hold and the action is repeated.

Movements from one point in the stream to another are made by floating off on a thread just as the newly hatched larva leaves the egg-mass: such movement is, of course, always down-stream. The larvæ can climb up such strands and regain their original situation.

The gradual development of the imaginal buds which eventually develop into the wings, halteres, legs and respiratory organs has already been noted (see page 17).

Frequently larvæ will be found that are parasitized. There are three common parasites: two species of Thelohania and a species of Serumsporidium are protozoan, one, a species of Mermis, is a nematode worm. When any one of these parasites is well developed it can be detected on examining the larva whole, alive or pickled. Thelohania takes the form of large white masses which may cause the abdomen of the larva to bulge asymmetrically. Serumsporidium takes the form of small spheres which fill the body cavity of the larva and can be seen, either loosely filling it, or packed tight against the skin. The coiled body of the nematode worm is easily seen through the semi-transparent skin and body contents. All these parasites live in the body cavity and, roughly speaking, displace the fat body that would develop therein. They do not affect the gut. In all three the larva eventually dies owing to a rupture of the body wall through which the parasite escapes. In parasitized larvæ the gonads are much atrophied and the imaginal buds remain very small.

*That is larvæ in which the parasites can be detected without killing and sectioning. Perhaps some larvæ with light infections may live and metamorphose.*
When mature and ready to pupate the larva spins a cocoon using the silken thread of salivary secretion to make it. In hirtipes the cocoon takes the form of a loose mat that completely covers the pupa within; sometimes, when a number of individuals pupate close together, the pupae appear to be embedded in a communal mat of silk. In all the other British species the cocoon is somewhat shoe- or slipper-shaped, with the toe always set upstream into the current. The shape of the cocoon is constant in each species and in some so characteristic that the species can be named from the cocoon alone. The cocoon is made in the same place as the larva have been living.

The pupa lies in the cocoon with the head down stream and the ventral surface against the substratum; the respiratory organs project to a greater or lesser extent. The pupa is held into the cocoon by means of the spines and hooks on the skin of the abdomen but it is able to move, shifting backwards and forwards and rotating itself within the cocoon. The duration of the pupal period varies amongst the different species and with the temperature of the water. Roughly it lasts from about four days to a fortnight.

When the adult is ready to emerge the pupa assumes a silvery appearance due to the accumulation of gases (air) between the transparent slightly brown pupal skin and the dark skin of the adult within which has ceased to be in intimate contact with the pupal cuticle. The gases increase in volume and distend the thin elastic cuticle of the pupal abdomen, with the result that, while the pupal skin of the abdomen remains firmly attached to the cocoon by means of the hooks and spines on it, the head and thorax are thrust out of the mouth of the cocoon (fig 14a). The pupal skin now splits longitudinally on the top of the thorax and the fly proceeds to emerge through this split. The gases continue to surround the emerging adult and prevent it getting wetted and then when it has finally emerged they form a bubble and carry the fly straight up to the surface of the water. The wings are ready to function as soon as the fly has emerged and it takes to flight immediately it reaches the surface of the water.

In no single species is there a complete exhaustive study of the habits of the adult. The males do not bite man or domestic animals and they are probably all nectar feeders. The females of several
species are known to be blood-suckers and in certain localities they constitute a serious pest to man and live-stock. There is always the possibility that the females of some species may attack birds and there are records (not British) of adults biting caterpillars and also biting vegetation. Copulation takes place soon after emergence and swarms of males have been observed flying about over the waters from which females were emerging. The females were promptly pursued by the males as soon as they took to their wings. Probably the female bites only after she has been fertilised. The ovaries of the freshly emerged female are in a very undeveloped condition, and, having fed, the female probably rests for a period of about a week. When the eggs have developed oviposition takes place. Most females probably die after laying their eggs but some may survive, take another meal and, after an interval, lay a second batch of eggs.

The females intent on biting tend to fly silently round their intended victim in a swarm before actually landing to bite. Sometimes these swarms are formed but no biting takes place. The bite usually causes a small weal and when the fly withdraws its mouthparts a small drop of blood frequently oozes out of the minute wound caused by the bite. (Those interested in the precise mechanism of biting should consult Jobling (1928) Bull. Ent. Res., 18: 211-236 where that of Culicoides is described in detail. The mouth-parts of Simulium (see Smart (1935)) closely resemble those of Culicoides.) Two species, equinum and salopiense, have the specialised habit of entering the ears of horses in particular and biting there; there may be so many bites within an ear that, if the finger is inserted and rubbed on the inside, it will come out covered with blood. Males will also swarm around the collector in the same manner as the females.

c. Nomenclature and Systematics.

The application of the specific names used for the British species has been carefully worked out by the late Dr. F. W. Edwards, mainly in three papers (1915, 1920 and 1939). Edwards’s application of the names was adhered to by Puri (1925) with some corrections that Edwards (1939) accepted. Other workers on the British Simuliidae have all accepted Edwards’s application of the specific names and it is followed in the present paper.
Edwards (1931, 1934 and 1939) regarded the Family Simuliidae as consisting of two genera. These are *Parasimulium* of which only one species, represented by a single specimen taken in California, is known, and *Simulium* to which all the other odd five hundred species occurring throughout the world belong. Enderlein (1930 and elsewhere) has recognised some 50 genera all told. North American writers, since the publication of a paper by Dyar and Shannon (1927), have more or less consistently recognised four segregates *Parasimulium, Prosimulium, Eusimulium* and *Simulium*. Enderlein (i.c.) does not divide his numerous genera into sub-genera. Edwards, on the other hand has divided the genus *Simulium* into sub-genera of which four are represented in the British fauna: *Prosimulium, Cnephiu, Eusimulium* and *Simulium* (restricted sense).

Some authors for reasons which cannot be gone into here, call the genus *Simulium* Latreille (1802) by the name of *Melusina* Meigen (1800). This results in the name Melusinidae being applied to the family instead of Simuliidae.

The other sub-genera (of Edwards 1931) not represented in the British fauna are *Austrosimulium, Gigantodax* and *Morops*.

Edwards (1931) recognised the seven sub-genera named but in a later paper (1934) he proposed to regard *Eusimulium, Morops* and *Simulium* as together constituting but one sub-genus *Simulium*. The main reason for this is that *Eusimulium* and *Simulium* (restricted) cannot be maintained as segregated, on the usually accepted criteria, when certain oriental species are considered.

This however does not detract from the utility of using the two segregates, *Eusimulium* and *Simulium* (restricted), in dealing with limited faunas where the different species are absent.

Edwards' classification of the British Species of 1939 is followed in the present paper. The writer takes this course because the classification is a convenient practical one for the British species and in order that the materials of the present paper may be directly compared with those of Edwards', Puri's, etc., papers. The writer intends to discuss the question of the generic classification of the Simuliidae elsewhere and it will be found that he proposes to classify the Simuliidae into two sub-families: (1) Parasimuliniæ with one genus *Parasimulium*; (2) Simuliiniæ with five genera *Prosimulium, Cnephiu, Austrosimulium, Gigantodax* and *Simulium* (restricted). These segregates correspond to those of the same name of Edwards (1934) but their status is raised from sub-genus to genus; no sub-genera will be recognised.
Genus *Simulium* Latreille

(Sub-genus *Prosimulium* Roubaud)

1. *hirtipes* Fries (1824)  
   *nigripes* Enderlein (1925)  
   *picipes* Stephens (1829)  
   (a nomen nudum)

(Sub-genus *Cnephia* Enderlein)

2. *tredecimatum* Edwards (1920)

(Sub-genus *Eusimulium* Roubaud)

3. *equinum* Linnaeus (1758)  
   *equinus* var. *orichalea* Enderlein (1922)  
   *maculatum* Meigen (of Verral and some other authors)  
   *lineatum* Meigen (of some authors)

4. *salopiense* Edwards (1927)

5. *latipes* Meigen (1804)

6. *aureum* Fries (1824)  
   *angustipes* Edwards (1915)  
   *flavipes* Stephens (1829)  
   (a nomen nudum)

7. *subexcisum* Edwards (1915)

8. *yerburyi* Edwards (1920)

9. *costatum* Friederichs (1920)

10. *angustitarsis* Lundström (1911)  
    *aureum* Fries ♂ of Edwards (1915)  
    *latipes* Meigen ♀ of Edwards (1915)  
    *lundstromi* Enderlein (1921a)  
    *falcata* Enderlein (1921a)  
    *jacula* Enderlein (1921b) (error for *falcata*)

---

**f. Check-list of British Simuliidae.**

Family SIMULIIDÆ

Genus *Simulium* Latreille

(Sub-genus *Prosimulium* Roubaud)

1. *hirtipes* Fries (1824)  
   *nigripes* Enderlein (1925)  
   *picipes* Stephens (1829)  
   (a nomen nudum)

(Sub-genus *Cnephia* Enderlein)

2. *tredecimatum* Edwards (1920)

(Sub-genus *Eusimulium* Roubaud)

3. *equinum* Linnaeus (1758)  
   *equinus* var. *orichalea* Enderlein (1922)  
   *maculatum* Meigen (of Verral and some other authors)  
   *lineatum* Meigen (of some authors)

4. *salopiense* Edwards (1927)

5. *latipes* Meigen (1804)

6. *aureum* Fries (1824)  
   *angustipes* Edwards (1915)  
   *flavipes* Stephens (1829)  
   (a nomen nudum)

7. *subexcisum* Edwards (1915)

8. *yerburyi* Edwards (1920)

9. *costatum* Friederichs (1920)

10. *angustitarsis* Lundström (1911)  
    *aureum* Fries ♂ of Edwards (1915)  
    *latipes* Meigen ♀ of Edwards (1915)  
    *lundstromi* Enderlein (1921a)  
    *falcata* Enderlein (1921a)  
    *jacula* Enderlein (1921b) (error for *falcata*)

---
(Sub-genus Simulium Latreille (restricted sense))

11. erythrocephalum Degeer (1776) and its var. sericatum Meigen (1830)
    argyreatum Meigen of Edwards before 1924

12. variegatum Meigen (1818)
    affinis Stephens (1829) (a nomen nudum)
    luteicornis Stephens (1829) (a nomen nudum)

13. ornatum Meigen (1818) and its var. nitidifrons Edwards (1920)
    trifasciatum Curtis (1830)
    sericeum Meigen (not sericeum Linnaeus)
    (of many authors)

14. monticola Friederichs (1920)
    obreptans Edwards (MS name (1920))

15. morsitans Edwards (1915)

16. tuberosum Lundström (1911)

17. noilleri Friederichs (1920)
    subornatum Edwards (1920)

18. reptans Linnaeus (1758) and its var. galeratum Edwards (1920)
    latinanus Enderlein (1921)

19. venustum Say (1828)
    austeni Edwards (1915)

A total of nineteen species and three varieties.

Note: The full synonymy of each species is not given above.
What has been done is to give a check list that shows all the names
applied by authors to species of Simulium stated by these authors to
occur in the British Isles.
Collecting, Preservation and Examination.

Adult flies will now and then be captured in the course of ordinary sweeping operations. They may be taken with a net as they emerge from the water after pupation or as they hover around an intended victim preparatory to biting—but beware of over exciting any already tormented bullock or horse with the wavings of the butterfly net. If the collector or an auxiliary proves attractive to the females these may be taken by slipping a glass tube over them as they bite; the same procedure can be followed with horses and cattle. Adults may also be reared from pupae. To do this select from a collection of live pupae the ones that are beginning to darken and in which the outline of the fly inside is beginning to show clearly (sometimes less mature ones can be reared). Take a petri dish, or better, a sporulating dish and put a filter paper, of a size larger than the diameter of the dish, inside so that the bottom of the dish is covered and some of the paper comes up the sides of the dish. Put water in the dish to thoroughly wet the paper and then invert momentarily to let surplus water run off. Lay the pupae on the paper on the bottom of the dish in their cocoons bottom side down. If the right amount of water is present a film of water will rise up from the paper and surround the cocoon, the pupa and the pupal respiratory organs; if there is insufficient water add a little carefully till the requisite film appears. Many pupae may be kept in such a dish. The thin film of water allows sufficient respiration for the pupae to develop. If a careful watch is kept on such a dish the flies may be captured and the particular pupa from which an individual fly has emerged spotted and then preserved in association with the fly. Single pupae can be reared in tubes with a strip of wetted filter paper, or in covered watch-glasses, etc.

More elaborate arrangements for pupa-rearing have been described. One of these consists of a piece of cloth dipping into water, the whole in a container from which the flies cannot escape. On the other hand, if very large numbers of pupae are available and it is not desired to associate the pupal exuviae with the adults, adults may be obtained by simply leaving the masses of pupae or the weeds to which they are attached, in a dish with some water near a closed window. On emerging the adults will fly towards the light and may be collected on the window panes.
Collectors who travel to their hunting grounds by motor-car should examine the head-lamps and other parts of the car to which insects get stuck; Simuliidae will frequently be found there. Simuliidae can also be collected in a net as the car goes along.

Eggs, larvae and pupae must be sought in the waters the species inhabit. Keep in mind the fact that in any particular section of a stream, which is not torrential, the early stages of Simulium are more likely to be found in places where there is a localised acceleration of the current in juxtaposition with a suitable substratum for them to live on. In torrential waters there are some places where even the early stages of Simuliidae cannot survive the poundings of the water. The conditions (see page 19) under which oviposition takes place will indicate where to look for the eggs: they are unlikely to be in deep water (say over a foot, unless there has been a flood) nor in very fast currents since it would be physically impossible for the female to enter these. Eggs can only be identified specifically by capturing the ovipositing female or by other circumstantial evidence. Eggs may be hatched by keeping them on wet filter-paper but the emerging first stage larvae cannot be identified at present and the only chance of rearing them is in rather elaborate apparatus in a laboratory (see further below).

The larvae and pupae of any given species usually occur in the same situation in a particular locality. Migrations of a sort do take place, thus the rotting of a water weed or trailing vegetation in the autumn will drive the larvae thereon into taking up winter quarters on stones in the stream bed. The pupae are, of course, firmly attached to the substratum and fortunately the larvae tend to remain attached to it also and so it is an easy matter to collect water-weeds or to lift the smaller stones out of the stream-bed. Beware, however, of lifting either weeds or stones out of the water and then letting them get immersed again; many larvae will detach themselves on such an immersion after exposure to the air.

Larvae and pupae on boulders or rocks in a stream may be taken by scraping them off with a knife or other implement and catching them in a net or on a gauze screen held downstream (an ordinary gardener’s birch-broom is very effective as a scraper). In small torrential hill streams it is often possible to alter the course of the water at a particular point, and expose the surface of some immovable rock or boulder, by removing smaller stones nearby.
Most of the situations in which the larvae and pupae occur can be reached by the gum-booted collector and many do not even require that protection. The early stages do tend to live toward the surface of deeper waters, especially in the summer time and in consequence they are usually on the upper parts of water-weeds or on the rocks toward the side of the river. They do, however, occur in the deeper waters of stoney bottomed rivers be the bottom solid rock or loose stones. To collect in such situations will require the use of thigh-boots or better still a bathing costume, and the current, etc., may be such that the use of a rope may be a wise precaution. The depths of the earth- or mud-bottomed river present no problems since any Simuliid early stages will be on water weeds, etc., and all that is needed are the requisite grappling hooks and patience with which to tear up such weeds and haul them to the bank for examination.

The larvae will live for some time in dishes of water and fully mature specimens may even make their cocoons and pupate under such conditions; such pupae will, however, almost certainly never survive. Larvae can be reared through their various stages—in some cases they have been reared from egg to adult—in the laboratory if either a continuous supply of unfiltered natural water containing food is available or compressed air is to hand to aerate and create currents in the fixed bulk of water in an aquarium (see Puri (1925) and Smart (1934) for descriptions of apparatus successfully used for rearing).

While it is possible to determine the species to which either a fully-grown larva, a pupa (in some cases a cocoon) or an adult belong, it is best, especially when making a survey of a region, to aim at collecting mature pupae and adults. Adults, however taken, should be pinned and dried in the usual way but if large numbers of one kind are available it may prove useful to preserve some of them in fluid. Pupae should be preserved in fluid but if mature pupae are taken then an attempt should be made to rear them since, with the adult and its associated pupal exuviae and the cocoon, there are two checks on any determination of one of the three. Such pupal exuviae are best preserved in fluid or mounted in balsam on slides; they, and the whole pupae, can however, be preserved dry on slips of card that can be put on pins or on the pin on which the corresponding adult is impaled.
The larvæ must always be preserved in fluid. Whatever method is used it should be one that makes the larva die in a distended condition. Any of the methods used for preserving aquatic larvæ may be used provided they give the desired distension. For many years the writer has consistently used Chlor-Picro-Acetic fixative to kill and pickle the larvæ, subsequently storing them in 70—80 per cent. alcohol. The use of such a fixative has the advantage that the material can be used for histological examination at a later date for which purpose specimens killed in hot water or alcohol are unsuited.

The keys to the adults, pupæ and cocoons presented below are based as far as possible on characters which can be seen with the aid of a good hand-lens. It will take practice to see the details of the male genitalia with the hand-lens. In the key to larvæ there are certain characters used which will not be seen under the hand-lens unless the user has considerable aptitude in its use. A Greenough-pattern binocular microscope with powers of magnification of about 24 is the ideal instrument; lenses which will give a lower power magnification are useful as are higher powers up to about 64. If it is desired to examine parts in detail under a still higher magnification, then it is well worth while to dissect the parts and make balsam mounts of them for examination under the monocular microscope.

In the case of the adult flies the genitalia of both sexes can only be properly seen when the whole terminalia are removed from the body of the fly, macerated in caustic solution in the usual way and mounted on a slide in Canada balsam or other medium. When mounting these parts use sufficient balsam to avoid compressing the genitalia unduly. If it is desired to examine the legs and the claws in detail it is advisable to make balsam preparations of them but this is quite unnecessary for ordinary purposes in the course of making identifications of specimens. Never macerate the wings or the venation will practically disappear in the hind part of the wing.

5Chlor-Picro-Acetic Fixative 12 parts volume 1%, Solution Picric Acid in 95%, Alcohol + 2 parts Chloroform + 1 part Acetic Acid. Put the specimens alive in the fluid and leave them in it overnight or for 24 hours; transfer to 70%, Alcohol; leave for some days; transfer to 70—80% Alcohol for permanent storage. The yellow stain is immaterial.
Whole pupae and their cocoons should be examined wet. There is no need to mount parts unless detailed study is anticipated. Pupal exuviae should, however, be mounted immediately, without maceration, on slides in Balsam. When doing this spread the parts of the pupal skin out extending the dorsal split in the thoracic region to allow the whole to be properly flattened out. Split the ventral wall of the cocoon so that it will lie flat and mount on the same slide as the pupal skin. When dealing with adults reared from mature pupa remember to label both the pinned adult and the pupal skin slide so that both can be reassociated at any time. The last larval skin if found sticking to a pupa or cocoon, should be mounted without maceration on the same slide.

Only the larger larvae can be identified. The younger stages have not yet been studied in detail. The preserved larvae should be examined wet. If killed in a well distended condition even the structure of the submentum and the other mouth-parts can be seen without dissection. If well distended the chances are that the anal gills will be protruding to an abnormal extent which is an advantage. The various parts of the head may, of course, be mounted in balsam on slides, but remember that the pattern on the dorsal surface of the head-capsule is better seen against the opaque contents of the head of the dead larva than when that part of the capsule is mounted in balsam on a slide.

The examination of the eggs presents no difficulties.

h. Acknowledgments.

The present paper on the British Simuliidae is based on the papers of Edwards (1915, 1920, 1927), of Edwards in Edwards, Oldroyd and Smart (1939) and of Puri (1925) and the writer hereby acknowledges his indebtedness to the work of these two authors. To a lesser extent the work of Peterson (1924) has been drawn upon.

The writer is indebted to Mr. N. D. Riley and the Trustees of the British Museum (Natural History) for nomination to a table at the Laboratory of the Freshwater Biological Association of the British Empire at Wray Castle for a short period in 1936 and for special leave granted at that time.
Figure 1 is reproduced from the “Natural History Magazine” and figure 12 from “British Blood-Sucking Flies” by Edwards, Oldroyd and Smart (1939) by permission of the Trustees of the British Museum (Natural History); figures 13, 14 and 17 are reproduced from the Bulletin of Entomological Research by permission of the Director, Dr. S. A. Neave, of the Imperial Institute of Entomology. I am grateful for this permission.

Certain other figures have been adapted or redrawn from those published by Edwards (1915, 1920 and 1927), Peterson (1924) and Puri (1925) as indicated in the relative legends.

Figure 8b was drawn by Mr. Arthur Smith; other original figures, and figure 1, were drawn by the writer.

KEY TO THE SUB-GENERA AND SPECIES (IMAGINES).

(Partly after Edwards (1920 and 1939).)

1. Radial sector forked distally (fig. 3); no pedisulcus (see fig. 5); no calcipala (see fig. 5); no spiniform macrotrichia on the costal vein, bristle-like ones only present; basal cell present (fig. 3); a large black species with dull yellow pubescence; male genitalia as in figure 11a.

   (Sub-genus Prosimulium) hirtipes

   — Radial sector simple, not forked; calcipala present but may be small; some spiniform macrotrichia present amongst the bristle-like ones (fig. 4) on the costal vein.

2. No pedisulcus; basal cell present; a large dull black species with macrotrichia on the upper side of the basal section of the radius (see fig. 3) and the vestiture of the dorsum consisting of erect dark hairs.

   (Sub-genus Cnephia) tredecimatum

   — Pedisulcus present, varying from a distinct notch to a mere excavation; no basal cell; vestiture of dorsum decumbent.

3. Basal section of the radius with macrotrichia on its upper side; fore tarsi slender and cylindrical; in the female the abdominal tergites are all matt; in the male the claspers are not flattened dorso-ventrally; species in which the fore tibiae
The coxite and clasper of: (a.) hirtipes; (b.) equinum; (c.) salopiense; (d.) subexcisum; (e.) laares; (f.) costatum; (g.) aureum; (h.) angustitarsis; (i.) erythrocephalum; (j.) variegatum; (k.) ornatum; (l.) monticola; (m.) morsitans; (n.) tuberosum; (o.) nollei; (p.) reptans; (q.) venum. In figures a.—q. the coxites and claspers are those of the right-hand side viewed from beneath, that is from the outside with the insect lying on its back. In figure a. the coxite and clasper is that of the left-hand side viewed from beneath; in addition the phallosome is shown (Scottish specimen). In b. and c. the coxites and claspers are those of the left-hand side, dissected so that they are viewed from their inner, upper surface; the small clasper will usually be found folded up on the upper inner surface of the coxite. The figures are not all to precisely the same magnification. (a. original; b. and c. after Edwards (1927); d.—q. after Edwards (1915 and 1920) and Peterson (1924).)
are dark and not obviously silvery and the body is usually without silvery markings. (Sub-genus *Eusimulium*) 4.

— Basal section of the radius naked above; fore tarsi somewhat flattened and appearing swollen distally; in the female the posterior abdominal tergites are shiny; in the male the claspers are flattened dorso-ventrally; species in which the fore tibiae are silvery on the outer side and the body is frequently with silvery markings (fig. 12b).

(Sub-genus *Simulium*) 12.

4. Membranous area of side of thorax with a small patch of soft hairs on it; hind basitarsus parallel-sided; in the female the claws are simple and exceptionally long and straight; species in which the legs are parti-coloured. 5.

— No patch of hairs on membranous area; hind basitarsus of male more or less thickened or spindle-shaped, of female parallel-sided; in the female the claws are toothed and not especially long or straight; legs variously patterned. 6.

Fig. 12 (a.) *Simulium salopiense* Edw.; thorax of female viewed from above; (b.) *Simulium ornatum* Mg.; head and thorax of female viewed from in front. (From Edwards, Oldroyd and Smart (1939).)
5. Smaller; wing length 2—2.5 mm.; thorax (fig. 12a) and legs paler; male with clasper definitely sub-terminal (fig. 11c); female grey.

— Larger; wing length 3—4 mm.; thorax and legs darker; male with clasper almost terminal (fig. 11b); female darker grey with a golden tinge when freshly emerged from the pupa.

6. The pedisulcus a rather shallow excavation; pubescence of the dorsum and other parts dull whitish-yellow; species in which the legs are entirely blackish. 7.

— The pedisulcus well formed, notch-like; pubescence of dorsum shining golden or brassy; legs brown or pale brown with the apices of their segments darkened. 9.

7. Males; genitalia as in fig. 11d

— Females

8. Pubescence of dorsum evenly distributed.

— Pubescence of the dorsum with the pale hairs tending to form a narrow median, and on either side a broader, longitudinal stripe.

9. Legs uniformly brown.

— Legs pale brown with the apices of the segments darkened. 11.

10. Hind basitarsus four times as long as it is broad; larger sombre species with much pubescence on the abdomen; wing length 4—4.5 mm.; male genitalia as in fig. 11f.

— Hind basitarsus three times as long as broad; smaller species with scarcely any pubescence on the abdomen, other than that on the abdominal scale; wing length barely 3.5 mm.; male genitalia as in fig. 11e.

*The male of yerburyi is not known.
11. Females with femora and tibiae pale brown with apices darkened; males with claspers short and conical (fig. 11g) *aureum*
   — Females with femora and tibiae as in *aureum* but with a darkened ring near the base of the tibiae; males with claspers long and of even width (fig. 11h). *angustiarsis*

12. Males.  
   — Females.  

13. Claspers as long as they are broad (fig. 11i); hind basitarsus nearly cylindrical.  
   — Claspers otherwise, three times as long as broad; hind basitarsus flattened, thickest in the vertical plane.  

14. A pair of almost triangular, lateral, silvery markings on the anterior region of the dorsum. *erythrocephalum*
   — These markings greyish, not silvery, and continued backwards as two narrow lines to the hind margin of the dorsum. *erythrocephalum* var. *sericatum*

15. Hind tibiae on the basal third, hind basitarsus on the basal half, conspicuously pale.  
   — Hind tibiae and basitarsi all dark or nearly so.  

16. Fore basitarsus five times as long as it is broad; a patch of hairs on the membranous area on the side of the thorax (fig. 1); genitalia as in figs. 6 and 11k. *ornatum*
   — Fore basitarsus six-and-one-half times as long as broad; never any hairs on membranous area.  

17. Clasper rather slender, external margin slightly concave, the spine nearly terminal (fig. 11j). *variegatum*
   — Clasper broader, external margin strongly convex in the middle, the spine definitely sub-terminal (fig. 11l). *monticola*

"The males of var. *nitidifrons* have not yet been recognised. Note that the hairs on the membranous area may get rubbed off."
18. Middle tibiae conspicuously yellowish at base.

— Middle tibiae all black.

19. Fore basitarsus about 5.5 times as long as broad; silvery markings of thorax inconspicuous; phallosome hairy; coxite and clasper as in figure 11o. 

— Fore basitarsus about 4 times as long as broad; two conspicuous rounded silvery spots on thorax; phallosome bare; coxite and clasper as in figure 11p.

20. Fore tibiae conspicuously silvery in front.

— Silvering of front tibiae much less conspicuous; clasper rather slender on apical half, with dorsal-projecting thumb-like process near the base (fig. 11i).

21. Clasper shaped somewhat as in tuberosum, but much broader, and thumb-like process shorter (fig. 11q); adminiculum differing from tuberosum and resembling morsitans. venustum

— Clasper much broader, without sub-basal thumb-like process; no spine towards tip (fig. 11m).

22. Front (above antennae) and face (below antennae) grey, matt (fig. 2a); shoulders with white markings (fig. 12b).

— Front blackish, shining (face usually grey).

23. Fore and middle femora mainly yellow.

— Femora mainly dark.

24. Claws with small sharp tooth near middle; patch of hair on pleural membrane (fig. 1).

— Claws not toothed; pleural membrane bare.

25. Shoulders with white markings as in ornatum (fig. 12b); claws toothed.

— Markings on shoulder different or absent; claws simple.

*The hairs on the membranous area may get rubbed off.
26. Abdomen more or less banded with pale grey; patch of hairs on pleural membrane.\(^9\) \textit{ornatum} var. \textit{nitidifrons}

— Abdomen entirely black; pleural membrane bare. \textit{monticola}

27. Face black, shining, like the front; legs mainly black. \textit{tuberosum}

— Face grey; legs more or less extensively pale. 28.

28. Thorax almost dull, with coarser pubescence. 29.

— Thorax somewhat shining, with much finer pubescence.\(^{10}\) 31.

29. Basal two-thirds of hind tibia clear yellow (hind femur almost all black, contrasting with the yellow base of tibia). \textit{repans}

— Basal half of hind tibia yellow, but less sharply distinguished from the black apical portion (hind femora dark but not such a marked contrast with the base of tibia). 30.

30. Rather less than basal half of middle tibia yellowish. \textit{venustum}

— Rather more than half middle tibia yellowish. \textit{morsitans}

31. Thorax plain; front coxae reddish. \textit{erythrocephalum}

— Thorax with traces of two greyish longitudinal stripes; front coxae blackish. \textit{erythrocephalum} var. \textit{sericatum}

\textbf{KEY TO THE SPECIES (PUPÆ).}

\textit{(Mainly after Puri (1925).)}

1. Respiratory organs consisting of broad thin-walled tubes, the main anterior and posterior branches, which are larger than the others, curving round the anterior part of the pupa as it

\(^9\) The hairs on the membranous area may get rubbed off.

\(^{10}\) Couplet 31 deals with \textit{erythrocephalum} and var. \textit{sericatum}. In these two forms there are a few fine hairs on the pleural membrane. These hairs are, however, much fewer and less conspicuous than those on the pleural membrane of \textit{ornatum}. The three species dealt with in couplets 29-30 have the pleural membrane naked. These hairs will only be detected if looked for very carefully with a highish magnification of the Greenough pattern binocular and consequently they are not a satisfactory character to use in the key.
lies within the cocoon which is shoe-shaped with rim thickened dorsally and ventrally and without windows (figs. 14, 15c). 2. Respiratory organs consisting of slender filaments with thicker, pigmented, walls (figures 8 and 13). Cocoons various (figs. 15 a–d, f–g). 3.

Fig. 13 Bases of pupal respiratory organs, viewed from the side to show the branching, of: (a.) ornatum; (b.) ornatum (showing variation); (c.) ornatum var. nitidifrons; (d.) nolleri; (e.) reptans; (f.) morstians; (g.) variegatum; (h.) monticola; (i.) venustum; (j.) tuberosum; (k.) erythrocephalum; (l.) latipes; (m.) aureum; (n.) angustitarsis; (o.) subexcisum; (p.) yerburyi; (q.) tredecimatum. The figures are not all of precisely the same magnification. (From Edwards (1920).)
2. The secondary branches of the respiratory organs rather finger-like, almost as broad as the two main anterior and posterior branches (fig. 14a, b).

— The secondary branches not so broad, more filamentous (fig. 14c).

![Fig 14](a) Empty pupal skin of S. equinum projecting from the cocoon showing how it has been pushed forward by the accumulation of gases in the abdominal region, × 10. (b.) The pupal respiratory organ, of the left-hand side, of S. equinum, × 25. (c.) The pupal respiratory organ, of the left side, of S. salopiense, × 25. (From Edwards (1920).)

3. Each respiratory organ comprising eight filaments.
   - six
   - four
   - eleven or more

4. The eight respiratory filaments arranged in pairs each pair on a long common stalk; the common stalks of the upper two pairs, which again have themselves a shorter common stalk, widely divergent from the lower two pairs (fig. 13p). Cocoon slipper-shaped with a long dorsal process round which the thickened rim of the opening is carried (see fig. 15h).

— Respiratory filaments otherwise; cocoon slipper-shaped without dorsal projection.
5. Respiratory filaments obviously arranged in pairs each pair with a short common stalk.

6. Respiratory filaments not obviously arranged in pairs (fig. 13d).
   Cocoon rather loosely woven, opening without thickened rim, irregular small openings may occur in the cocoon but these are hardly large enough to be called "windows" (fig. 15b).

6. The common stalks of the two lower pairs of filaments joining to form a short but obvious common stalk before it, in turn, joins the common stalks of the two upper pairs at the base of the respiratory organ (fig. 13f); the pair of terminal spines at the end of the abdomen absent or reduced to mere tubercles. Cocoon closely and toughly woven, without any windows, and with thickened rim.

7. Length of filaments much less than length of pupa, the common stalks of each pair very short, all filaments of equal thickness, the upper pair slightly shorter than the others (fig. 13e). Cocoon toughly woven with thickened rim and windows (fig. 15d).
   (And probably of reptans var. galeratum the pupa of which has not been described.)

7. The lower two pairs of respiratory filaments not as above but all four pairs having their separate common stalks running together to form the base of the whole respiratory organ; pair of terminal spines present at end of abdomen.

8. The common stalks of the two lower pairs of filaments usually longer than the stalks of the two upper pairs (fig. 13a, b).

8. The common stalks of the two lower pairs of filaments usually longer than the stalks of the two upper pairs (fig. 13a, b).

ornatum

ornatum var. nitidifrons

— All four pairs of filaments with short common stalks of about equal length (fig. 13c).
9. Upper pair of filaments of the respiratory organ widely divergent from the four filaments of the lower two pairs, the common stalks of each pair long, those of the two lower pairs joining to form a common stalk which joins the common stalk of the upper pair at the base of the organ (fig. 13o). Cocoon slipper-shaped with long dorsal process round which the thickened rim of the opening is carried (fig. 15h). *subexcisum*

— The common stalks of the three pairs of filaments short and not widely divergent as in the previous species. Cocoon slipper-shaped without dorsal process.

10. Filaments of the respiratory organ tending to spread apart from each other, all about the same thickness. Cocoon closely and toughly woven, with thickened rim, no windows. 11.

— Filaments tending to remain together and lie parallel with each other, the lower pair slightly or markedly thinner than the upper pair.

11. All three pairs of respiratory filaments with distinct short common stalks (fig. 13i); terminal spines on abdomen present. *venustum*

— Upper and lower pair of filaments with very short common stalks or almost sessile, middle pair, without any common stalk, arising direct from base of respiratory organ (fig. 13k). *erythrocephalum* and var. *sericatum*

12. Upper pair of respiratory filaments much thicker than the others, filaments shorter than the pupa (fig. 13h). Cocoon closely woven, no windows. Rim of opening thickened; trichomes branched. *monticola*

— Upper pair of filaments only slightly, if at all, thicker than the others, either shorter or longer than the pupa; trichomes simple.

13. A pair of rounded dorsal tubercles ("Patagia") on the anterior part of the thorax. Filaments shorter than pupa (fig. 13g);
cocoon much larger than pupa, loosely woven laterally in front, rim slightly thickened (fig. 15a).  

variegatum

— No such tubercles. Filaments longer than the pupa (fig. 13j). Cocoon short, rarely extending beyond about the middle of the pupal thorax, closely woven, without windows, rim of opening thickened.  

tuberosum

14. Respiratory filaments arranged in two distinctly stalked pairs. 15. Filaments all arising from a common base or nearly so. 16.

15. Filaments coarser (fig. 16a). Cocoon slipper shaped closely woven, rim thickened, without anterior dorsal projection.  

costatum

— Filaments finer (fig. 13l). Cocoon slipper-shaped, closely woven, with thickened rim which is drawn out into an anterior dorsal projection (figs. 15f and g).  

latipes

16. Filaments very stout at base, the root of upper one sharply divergent from the others (fig. 13n). Cocoon slipper-shaped, the thickened rim of the opening drawn out into a median dorsal anterior process, closely woven.  

angustitarsis

— Filaments not markedly swollen at base (fig. 13m). Cocoon slipper-shaped, closely woven, rim of opening thickened but not drawn out into a median process.  

aureum


tredecimatum

— Sixteen (? or more)¹⁶ filaments (fig. 8b). Terminal abdominal spines in the form of strong hooks. Cocoon loosely woven and without definite shape, lacking a definite opening anteriorly  

hirtipes

¹⁶British pupæ of hirtipes have 16 filaments arranged as in figure 8b. Material from other countries has been described as having up to 50 or 60 branches as the result of further branching of the 16 basic primary and secondary branches shown in the figure. This foreign material may, of course, be misidentified and really be some other species than hirtipes.
KEY TO THE SPECIES (COCOONS).

The number of filaments in the pupal respiratory organ is shown in brackets (except equinum and salopiense).

1. Cocoon irregular without definite anterior opening hirtipes (16).
   — Cocoon shoe-shaped (fig. 15c) 2.
   — Cocoon slipper-shaped (figs. 15a, b, c, d, f). 3.

2. Respiratory organs finger-like (fig. 14). equinum, salopiense
   — Respiratory organs of the usual filamentous type. tredecimatum (11—14)

3. With a projecting anterior dorsal process (fig. 15f, g, h). 4.
   — Without any such process (fig. 15a, b, c, d). 6.

4. Process formed entirely of the thickened rim of the opening of the cocoon (fig. 15g).
   — Process itself showing a thickened edge (fig. 15h). yerburyi (8), subexcisum (6)

5. The projecting process short (about .8 mm.). angustitarsis (4)
   — The projecting process long (about 1.3 mm.) (fig. 15g). latipes (4)

6. Much larger than pupa within, rather loosely woven but without definite windows antero-laterally (fig. 15a). variegatum (6)
   — Smaller than pupa within, the rim of the opening rarely reaching beyond the middle of the thorax of the pupa, closely and toughly woven, without windows, rim thickened. tuberosum (6)

   — Cocoon about the same size as pupa. 7.
Fig. 15 Cocoons of: (a.) variegatum; (b.) nolieri; (c.) ornatum; (d.) reptans; (e.) equinum; (f. and g.) latipes; (h.) subexcisum; a., c., d., e. and f. are of the whole cocoon viewed from the side; b. is of the whole cocoon viewed from above; g. and h. are of the anterior part of the cocoon viewed from above, to show the dorsal projections. Not all to the same scale of magnification. Somewhat diagrammatic. (Adapted from Pur i (1925).)
7. Cocoon toughly and closely woven, with thickened rim, without windows (fig. 15c.)

- Cocoon rather loosely woven, without marked rim, with openings in wall antero-laterally though these are hardly definite enough to be called windows (fig. 15b).

- Cocoon toughly woven, with thickened rim and definite windows (fig. 15d).

**KEY TO THE SPECIES (LARVAE).**

*(In part after Puri (1925).*

1. Ventral papillae well-developed (fig. 16c).

— Ventral papillae absent (fig. 9) or rudimentary.

2. Anal gills branched (fig. 16c); (fig. 17j).

— Anal gills simple, finger-like (fig. 9)

3. Ventral papillae parallel sided at base; antennae short; (fig. 17h).

— Ventral papillae conical (fig. 16c); antennae long and slender.

4. Fronto-clypeus with anterior median and posterior median group of discs practically confluent, they and the lateral group all pigmented and enveloped in a general suffused darkening of the integument (fig. 17k).

— Fronto-clypeal pigment spots around and including disc groups sharply defined and not confluent.

5. Posterior median spot very dark, darker than the anterior median spot or the lateral spots, equilaterally triangular in shape (fig. 16b).

— Posterior median spot no darker than others, elongate in shape (fig. 17l).

---

12 In couplet 7 see the previous key to pupae, at couplet 2, for characteristics that will separate species with the same number of filaments in the respiratory organ. It must not be implied that the cocoons of all these species in couplet 7 are identical, they are not, though they do conform to the same general pattern.
Fig. 16 (a.) the base of the pupal respiratory organ of Simulium costatum Fried. (b.) the larval head of the same species viewed from above; (c.) the hind end of the larva of Simulium latipes Meigen to show the ventral papillae and anal gills. ((a. and b.) after Peterson (1924), (c.) after Puri (1925).)

Fig. 17 The head-capsules of mature larvae, viewed from above and somewhat diagrammatic, of: (a.) ornatum; (b.) variegatum and monticola; (c.) nolleri; (d.) reptans; (e.) reptans var. gederatum; (f.) morsitans; (g.) venustum; (h.) erythrocephalum; (i.) equinum; (j.) latipes; (k.) aureum; (l.) angustitarsis; (m.) subexcisum. Not all to the same scale of magnification. (From Edwards (1920).)
6. Gills simple, finger-like (fig. 9).  
— Gills branched (fig. 16c).

7. Basal two segments of the antennæ showing no traces of sub-division.  
— Basal two segments of the antennæ with sub-dividing annulations.

8. The two basal segments of the comparatively short antennæ similarly pigmented to the apical segments; head-capsule palish brownish-yellow with the fronto-clypeal discs deeply pigmented and sharply defined (fig. 17i). *equinum*

— The two basal segments of the antennæ pale, the two apical segments dark; head-capsule dark brown, the area around and including the fronto-clypeal disc group only slightly darker, not forming clearly defined spots.

9. Fronto-clypeus pyriform in outline with its lateral margins tending to converge anteriorly; lateral sub-mental teeth bifid, median trifid. *hirtipes*

— Fronto-clypeus “normal” with its lateral margins running more or less parallel to each other as they pass forward; sub-mental teeth short and simple. *tredecimatum*

10. Basal two segments of the antennæ with five additional annulations making the two segments appear to consist of a total of seven segments. *subexcisum*

— Basal two segments with one complete and one partial additional annulation making the two segments appear to consist of a total of three or four.

11. Dark spots on the fronto-clypeus somewhat diffuse, those on the side of the head faint and not extensive (figs. 9, 17a). *ornatum*

— And perhaps the larvae of *salopiense* Edw. which have not yet been described.

— And perhaps *yerburyi* Edw. the larva of which is not known.
— Dark spots on fronto-clypeus sharply defined, those on the side dark and very extensive.  

ornatum var. nitidifrons

12. Gills with the branches short almost papilliform.  13.
— Gills with the branches at the least digitiform.  15.

13. Minute ventral papillae present.
— No such minute papillae; (fig. 17c).

nolleri

14. Fronto-clypeus with a large dark area embracing all the discs of the fronto-clypeus except the anterior ones of the anterior median group (fig. 17e).

reptans var. galeratum

— Fronto-clypeus with dark pigmentation confined to the posterior margin and to two small discrete patches round the lateral groups of discs (fig. 17d).

reptans

15. Fronto-clypeal discs dark (fig. 17b); antennae with one complete and one incomplete extra annulation on the two basal segments.

— Discs pale; antennae without any extra annulation or with only one extra annulation on the two basal segments.

16.

16. Up to eighty-five rows of hooks in the “posterior sucker”; rectal scales fewer, paler and on a more confined area (as in S. nolleri); anal gills with 8-10 branches.

variegatum

— Ninety or more rows of hooks in the “posterior sucker”; rectal scales more numerous, darker and on a more extensive area (as in S. ornatum); anal gills with 6—9 branches.

monticola

17. Head-capsule very light golden colour with practically no pigmented areas; antennae with one extra annulation on basal two segments.

tuberosum

— Head-capsule darker golden- or light-brown; an H-shaped pigmented area amongst the fronto-clypeal discs (which are themselves unpigmented).
18. Upper arms of the H-shaped pigmented area on the fronto-
clupeus as long as the lower arms and extending as far forward
as the anterior discs of the anterior group (fig. 17f).

— Upper arms of the H-shaped pigmented area much shorter than
the lower arms, not extending forward as far as the middle of
the anterior median group of discs (fig. 17g).

NOTES ON ECOLOGY AND DISTRIBUTION.

Simulium hirtipes Fries. Found only in the Scottish Highlands
where it breeds in torrential hill streams that do not dry out com-
pletely in the summer. Bites man. May—July. Only one generation
in the course of the year.

No Lake District records.

Simulium tredecimatum Edwards. The only British record
remains the original one of larvae taken "from stomach of trout,
England"; nothing is known of the locality or the collector. The
species has been recorded from Norway.

No Lake District records.

Simulium equinum Linnaeus. Lowland-species breeding on
water-weeds in rivers where there is a steady powerful current.
Bites man, horses (see page 23), oxen and sheep; a pest. Wide-
spread but not recorded north of the Forth area. March-November,
two, three or perhaps more generations. The adults from the over-
wintering larvae are larger than those of other generations.

Lake District records are:—Great Salkeld (Britten).

Simulium salopiense Edwards. Lowland-species breeding on
water-weeds in rivers where there is a steady powerful current.
Bites man, etc., as in equinum; a pest. Only recorded from the
west and south-west of England. March-November, two, three,
or perhaps more generations.

No Lake District records.
Simulium latipes Meigen. Generally distributed, breeding in small streams and ditches that tend to dry up in summer, occasionally larvae and pupae are found in larger streams. Bites man. Mainly April—June. Some evidence that eggs can survive the drying up of the stream in summer being laid in damp places under stones. Adults may appear as late as September.

Lake District records are:—High Wray (pupæ) 16/6/36 (Smart); Red Nab (pupæ) 16/6/36 (Smart); Mossdale Beck (pupæ) 19/6/36 (Smart); River Duddon (pupæ) 19/6/36 (Smart); Sail Beck, Buttermere (pupæ) 14/7/32 (Smart).

Simulium aureum Fries. Generally distributed, breeding habitat, oviposition habits, number of generations and times of appearance as in S. latipes (see above). Recorded as biting goslings in North America.

No Lake District records.

Simulium subexcisum Edwards. Generally distributed but rare. Breeding place as in latipes, number of generations probably as in latipes. April—May.

No Lake District records.

Simulium yerburyi Edwards. Only known from a pupa and the emergent adult taken in Herts. (Knebworth, in May) and adults taken in Inverness (Nethybridge, in June), and Nairn (in May). Pupa was taken along with pupae of latipes.

No Lake District records.


No Lake District records.

Simulium angustitarsis Lundström. Not yet recorded outside the southern, south-eastern and midland counties of England and Wales; breeds in weedy rivers with a moderate current. April—October. Two or more generations.

No Lake District records.
Simulium crythrocephalum Degeer. Breeds in weedy rivers with a moderate current. Widespread but especially abundant in midland and eastern counties of England; in Scotland only recorded from the Lowlands. Bites man and oxen; a pest. The spring adults from the over-wintering larvae are larger and distinctively marked, they are called var. sericatum and appear in April—May. Main summer generation of adults about June with subsequent generations during the rest of the summer till September.

No Lake District records.

Simulium variegatum Meigen. Generally distributed throughout Wales, West and North of England and Scotland where swift stony streams or smaller rivers, such as it breeds in, occur in valleys amongst hills and mountains. Bites horses. April—September. Two or more generations.

Lake District records are:—River Sprint at Garnett Bridge (pupæ) 26 6/36 (Smart); Ewebank Scar, Kirkby Stephen (pupæ) 22/7/12 (Wilkins); Aysgarth Force (pupæ) (Grimshaw).

Simulium ornatum Meigen. A lowland species mainly in larger streams and smaller rivers where there is a moderate current and a considerable amount of aquatic vegetation; also found in stony bottomed streams. Bites man, horses and oxen. Generally distributed wherever suitable breeding streams occur. March—November. Two or more generations. The occurrence of odd pupæ at almost all seasons of the year in favourable localities indicates that adults are emerging all the year round in varying numbers. Var. nitidifrons is recorded from the New Forest, Devon, Shropshire, Wigton and Barra.

There are no records of this species from the Lake District. It would, however, be most surprising if it was completely absent from the entire region.

Simulium monticola Friederichs. A species of the rapid, rock or stony-bottomed hill and mountain streams, generally distributed where these occur in the west and north of England and Scotland. May—August. At least two generations.

Lake District records are:—Straining Well, Thirlmere (pupæ), 18 6/36 (Smart); Sour Milk Gill, Buttermere (pupæ), 14/7/32

Lake District records are:—Blelham Beck, Low Wray (pupæ), 29/6/36 (Smart).

Simulium tuberosum Lundström. A common hill-species in the north of England and Scotland; also recorded from Devon (River Dart at Holne Chase, River Teign below Fingle Bridge). Breeds in rapid rivers on stones. Bites man, oxen and dogs. May—November. Probably two or more generations.

Lake District records are:—Bassenthwaite (Hartley); Wasdale, at head of Lake (Imago) 19/6/36 (Smart).


No Lake District records.

Simulium reptans Linnaeus. A hill-species common in Wales, west and north of England and Scotland breeding in swift streams on stones or water plants if present, seldom found in treeless valleys. Bites man, oxen and dogs. May—July. Probably two generations at least. Var. galeratum only recorded from River Otter, Tipton St. John, Devon, as larvae in June.

Common in the Lake District. Actual localities are:—Bassenthwaite (Hartley); Sail Beck, Buttermere (pupæ), 14/7/32 (Smart).

Simulium venustum Say. A lowland species breeding in weedy rivers with a moderate current. Recorded only from the south and south-east of England. In America it bites man, horses and ducks, a pest. April—July. Probably two or more generations.

No Lake District records.
REFERENCES.

The important systematic papers on the British species of *Simulium* are:

**Edwards, F. W.**


**Edwards, Oldroyd and Smart**

**Puri, I. M.**

Some papers dealing with the natural history of the British species are:

**Pentelow, F. T. K.**

**Smart, J.**

For wider reading:—


ENDERLEIN, G. (1930) Der heutige Stand der Klassifikation der Simuliiden. *Arch. Klassif. Phylog. Ent.*, 1: 77-97. (Enderlein has provided an elaborate classification for the family breaking the genus up into numerous more restricted genera. The paper is of no use for species identification. In German.)

ENDERLEIN, G. (1936) *Tierwelt Mitteleuropas*, 6, iii teil, 2 lief., xvi. Leipzig. (On the Diptera of Central Europe: keys to the species of *Simulium*, as they are recognised by Enderlein, are given. In German.)


(Edwards views on the generic classification of the Simuliidae are presented in this and the previous paper.)


(On the Danish species and their biology. In Danish.)


(Keys to, and notes on, the French species. In French.)
SMART, J.  

STEWARD, J. S.  

STRICKLAND, E. H.  

STRICKLAND, E. H.  

(These two papers are the best introduction to the parasites; they are not, however, the very latest.)

WILHELM, J.  

(A rather over-condensed survey-monograph with extensive bibliography. No use for systematic work. In German.)
III. APPENDIX. Bibliography of other papers (excluding short notes, etc.).


5. Antecologuiical Systematics examined as a Practical Problem. in Huxley, J. H., The New Systematics:476-482. 1940.


