

TRANSACTIONS

OF

THE NORFOLK & NORWICH NATURALISTS' SOCIETY



Edited by E. A. ELLIS

VOL. 18

PART 5

CONTENTS

THE ROTIFER FAUNA OF EAST NORFOLK, BY H. G. S. WRIGHT - - - - -	Page 1
NOTES ON A PRELIMINARY MAP OF SOME FEATURES OF THE DRIFT TOPOGRAPHY AROUND HOLT AND CROMER, NORFOLK, BY R. G. WEST - - -	„ 24
SENECIO SQUALIDUS L. IN THE BRITISH ISLES—3, EAST ANGLIA, BY D. H. KENT - - - - -	„ 30

PRICE 5/.

Obtainable only from the Society.

NORWICH.

Printed by the Soman-Wherry Press Ltd., Norwich.

Published 18th April, 1957

THE ROTIFER FAUNA OF EAST NORFOLK

*Notes of New Species and Some Rarities Among
Sessile Forms.*

BY H. G. SUMMERFIELD WRIGHT.



It is difficult to account for the neglect of that great class of microscopic aquatic animals, the Rotatoria, by Norfolk naturalists, whose county is so strongly characterised by Broads, rivers, lakes and other bodies of water offering quite boundless opportunities to students of fresh water invertebrates of all kinds.

The strange fact that so little advantage has in the past been taken of these facilities as regards the "Wheel Animalcules" which a few generations ago were the special and enduring enjoyment of most amateur microscopists, might reasonably be supposed to act as an incentive to those of to-day who delight in seeking out the beauties and wonders of Nature, and who have easily within their reach a domain so rich in largely unknown treasures.

So far as can be ascertained, no serious effort has ever been made to compile a comprehensive list of the Rotatoria living in Norfolk waters, though one or two workers of other days have made restricted notes. The preparation of a truly representative record within a reasonable time would now require the collaboration of a number of enthusiastic microscopists, unless the county can produce a zealot with the knowledge and skill, not to mention physical endurance to enable him to do for Norfolk what Mr. A. L. Galliford of Liverpool, has done for West Lancashire, Cheshire, North Wales and an even wider field. The possibility is, of course, that there are already pond-life students pursuing their hobby in isolation in various parts of the county, whose efforts might be given a new impetus and value if they could be focussed upon a definite piece of work.

Well over a century has elapsed since Thomas Brightwell discovered the two sexes of a Rotifer then new to science "in a small pond immediately without the city of Norwich," and thus produced the first proof of the dioecious character of at least one species of these minute animals. That was in 1841, and he published his account in "Annals of Natural History" seven

years later. In 1850, Philip Henry Gosse (who discovered another species of the same genus in the Serpentine) fully described the Norwich find and gave it the name *Asplanchna brightwelli*.

By the kindness of Mr. E. A. Ellis, the writer has been able to consult a list of 38 species of Rotatoria recorded by Mr. F. C. Headley, a visitor to the area, between August 11th and September 1st, 1901, at Barton and Sutton Broads, and another of 50 species taken by Mr. H. E. Hurrell, of Great Yarmouth, from various sources, mainly in Norfolk. This latter list was included in a paper Mr. Hurrell read before the Norfolk and Norwich Naturalists' Society, 1902, and published in the Transactions, Vol. VII, 1899-1904.

Reference to another list of Rotatoria from this area is made in the same society's Transactions, Vol. X, Pt. V, 1918-19, wherein Dr. Robert Gurney, of Ingham Old Hall, the authority on Copepoda and Cladocera (at that time hon. treasurer of the N.N.N.S.) mentions that in November, 1904, "about 120" species were collected during six days' work at Sutton Broad Laboratory by the Rev. R. Freeman. This remarkable catch must be related to the fact that the collector was one of the leading rotiferists of his day, and was responsible for the preparation, in collaboration with another first-class worker and artist, F. R. Dixon-Nuttall, of a splendid monograph on "The Rotatorian Genus *Diaschiza*" (now *Cephalodella*) published in the Royal Microscopical Society's Journal in 1903. The present writer is further obliged to Mr. Ellis for a list of the Rev. R. Freeman's captures, which were made at Sutton Broad, dykes and marsh and at Barton and Hickling Broads. The total of species therein is 112, but three of the identifications are doubtful and are now omitted.

This reference to the 1904 haul is incidental to a record of Dr. Gurney's own success in finding a lone example of the leaping Rotifer, *Pedalia mira*, together with "an exceptionally rich tow-net collection of other Rotifers, including *Polyarthra platyptera*, *Asplanchna* and *Triarthra*," from the River Ant by Ludham Bridge in August, 1906. At that time *Pedalia mira* was supposed to be rare, but Dr. Gurney mentioned a pond in Windsor Park and Langmere and Ringmere in Norfolk as being prolific sources in the year in which he wrote, 1919.

The most recent available reference to the Rotatoria of this county was contained in an address which Mr. Hurrell intended to deliver as President-elect of the N.N.N. Society in 1942, in which year he died. In this he wrote: "There are over 800 species (of Rotatoria) in the latest published lists, most of which have been found in Norfolk waters." It is greatly to be regretted that this statement cannot now be enlarged upon, unless, possibly, the archives of the now defunct Norwich Microscopical Society include some relevant details.

There is another reason, additional to the need to fill this unseemly gap in the county's faunal records, why the writer would commend the study of the Rotatoria. Though they are, as the pioneer Henry Baker wrote more than two centuries ago, "small indeed and seemingly of no consequence," they include some of the loveliest of all living creatures, and, while thus giving their beholder the purest aesthetic pleasure, their movements and habits and their strange life histories pose many questions whose solution taxes his utmost powers of observation and interpretation. There is, too, a spice of healthy excitement in the "hunt," for never yet was there a rotiferist who did not hope, on setting out on a foray, that he would this time collect a rarity if not something never found before. And even now, when the published lists are nearly double those available in Mr. Hurrell's day, one may still add to the total—nowhere more probably than in the untapped sources of Norfolk.

Ten years after Mr. Headley and Mr. Hurrell completed the records to which reference has been made, a very notable effort was brought to a conclusion by an American specialist, H. K. Haring, who rescued the classification and naming of the Rotatoria from the chaos into which they had fallen. His strict application of the International Code of Zoological Nomenclature produced many violent but necessary corrections and eliminations, which for long were resisted by those who had already found it sufficiently difficult to memorise the tongue-twisting names in vogue before Haring produced his revolutionary "Synopsis of the Rotatoria" in 1913. Nevertheless, this fundamental piece of research, followed by other revisions, came to receive world-wide acceptance (though slowly and not even yet completely in our own country) and the serious worker of

to-day must "know his Herring" if he would follow what is being done abroad or make any contribution of his own.

In extracting the purely Norfolk records from the short catalogues that have come to his notice the present writer has translated them into modern terms so far as it is possible to identify the animals listed. The total of each list is reduced somewhat by taking account of synonyms.

Mr. Headley's List from Barton and Sutton Broads.

Order PLOIMA.

Family Notommatidae.—*Notommata tripus* Ehr., *N. cerberus*, Gosse, *Cephalodella gibba* (Ehr.) *C. forficula* (Ehr.) *Monommata longiseta* (Müller) *Dicranophorus forcipatus* (Müller).

Family Synchaetidae.—*Polyarthra trigla* Ehr.

Family Gastropodidae.—*Ascomorpha ecaudis* Perty.

Family Trichocercidae.—*Trichocerca porcellus* (Gosse) *T. scipio* (Gosse) *T. cristata* Harring, *T. bicristata* (Gosse) *Diurella tenuior* (Gosse).

Family Asplanchnidae.—*Asplanchna priodonta* Gosse.

Family Brachionidae.—*Brachionus quadridentatus* Hermann, *B. angularis* Gosse, *Keratella quadrata* (Müller) *Platytias patulus* (Müller).

Family Euchlanidae.—*Euchlanis dilatata* Ehr. *E. triquetra* Ehr. *Lecane luna* (Müller) *Monostyla quadridentata* Ehr., *Lepadella ovalis* (Müller), *Cohurella deflexa* (Ehr.) *C. caudata* Ehr., *Mytilina mucronata* Ehr., *M. ventralis brevispina* (Ehr.) *Trichotria pocillum* (Müller).

Family Testudinellidae.—*Testudinella patina* (Hermann) *Pompholyx complanata* Gosse.

Order BDELLOIDA.

Sub-Family Philodininae.—*Philodina megalotrocha* Ehr., *Rotaria rotatoria* (Pallas).

"No fixed Rotifers were found, though much searched for."

Mr. Hurrell's List from Norfolk.

Order PLOIMA.

Fam. Notommatidae.—*Notommata pachyura* (Gosse) *Cephalodella gibba* (Ehr.) *Monommata longiseta* (Müller) *Dicranophorus forcipatus* (Müller).—Caister Road.

Fam. Synchaetidae.—*Synchaeta pectinata* Ehr., *S. tavina* Hood, *S. gyrina* Hood, *S. tremula* Ehr., *S. cecilia* Rousselet.—Brackish ditches on Acle New Road, Yarmouth, and ditches on Caister Road, Yarmouth.

Fam. Trichocercidae.—*Trichocerca elongata* (Gosse).—Caister ditches.

Fam. Asplanchnidae.—*Asplanchna brightwelli* Gosse.—Ormesby Broad.

Fam. Brachionidae.—*Brachionus calyciflorus* (Ehr.)—Ormesby and Belton. *B. plicatilis* Müller.—Acle New Road, Yarmouth. *B. angularis* Gosse.—Scratby. *B. urceolaris* Müller—Ormesby. *B. quadridentatus* Hermann.—Ditches at Yarmouth. *Keratella quadrata* (Müller).—Ormesby. *Notholca striata* (Müller) and *N. striata* var *labis* Gosse.—Ditches at Southtown, Cobholm and Caister Road.

Fam. Epiphanidae.—*Epiphanes senta* (Ehr.).—Ditch at Caister Road and ponds at Caister and Scratby. *Rhinoglena frontalis* (Gosse).—Ditch on Caister Road and pond at Burgh St. Peter.

- Fam. Euchlanidae.—*Euchlanis dilatata* Ehr.—Caister Road marshes. *Squatinella lamellaris* (Müller).—Caister ditches. *Trichotria pocillum* (Müller).—Caister Road marshes.
- Fam. Filiniidae.—*Filinia longiseta* Ehr., *F. breviseta* (Gosse).—Ormesby Broad.
- Fam. Testudinellidae.—*Testudinella patina* (Müller), *T. mucronata* (Gosse).—Ormesby Broad. *T. elliptica* (Ehr.).—Cobholm. *Pompholyx sulcata* Hudson.—Ormesby Broad.

Order FLOSCULARIACEA.

- Fam. Flosculariidae.—*Floscularia ringens* (Linnaeus).—Yare at Brundall.
- Fam. Conochilidae.—*Conochilus hippocrepis* (Schrank), *C. unicornis* Rousselet.—Ormesby Broad.

Order COLLOTHECACEA.

- Fam. Collothecidae.—*Collotheca ornata* (Ehr.).—Ditches at Southtown and Cobholm.

Order BDELLOIDA.

- Sub-Fam. Philodininae.—*Philodina citrina* Ehr., *P. roscola* Ehr.—Caister ditches. *Rotaria rotatoria* (Pallas), *R. tardigrada* (Ehr.), *R. neptunia* Ehr.—Pond near Great Ormesby.
- Rev. R. Freeman's list from Sutton Broad, dykes and marsh, and Barton and Hickling Broads.

The collecting-stations are indicated in parentheses as follows: Sutton Broad (A); Sutton dykes (B); Sutton marsh (C); Barton Broad (D); Hickling Broad (E). The addition of "x" signifies that a species was common or abundant; the absence of this sign denotes that a species was uncommon or very scarce.

ORDER PLOIMA.

Sub-ORDER NOTOMMATOIDEA.

- Sub-family Proalinae.—*Proales decipiens* (Ehr.) (A.BxDxFx) *P. felis* (Müll.) (A). *P. daphnicola* (Thompson) (A.Bx) on *Daphnia pulex*, *Sida crystallina* and *Eurycerus lamellatus*.
- Sub-family Notommatainae.—*Notommata aurita* (Müll.) (AxB.D.E.). *N. copeus* Ehr. (A.D.) *N. cyrtopus* (Gosse) (A.B.D.) *N. pachyura* (Gosse) (A.) *N. saccigera* Ehr. (Ax) *N. tripus* Ehr. (B.E.) *Taphrocampa annulosa* Gosse (A.Bx) *Pleurotrocha petromyzon* (Ehr.) (AxE.) *Cephalodella derbyi* (Dixon-Nuttall and Freeman) (A.) *C. auriculata* (Müll.) (AxB.DxEx) *C. eva* (Gosse) (A.B.Dx) *C. exigua* (Gosse) (A.D.) *C. forficata* (Ehr.) (AxB.DxE.) *C. gibba* (Ehr.) (A.B.DxE.) *C. globata* (Gosse) (D.E.) *C. gracilis* (Ehr.) (A.) *C. hoodi* (Gosse) (AxB.Ex) *C. megaloccephala* (Glasscott) (D.) *C. sterea* (Gosse) (A.B.E.) *C. tenuior* (Gosse) (A.B.D.) *C. ventripes* (D-N.) (AxB.) *C. catellina* (Müll.) (A.B.D.E.). *Eosphora ehrenbergi* (Weber). (A.D.) *E. aurita* (Ehr.) (A.) *Scardium longicaudum* (Müll.) (B.) *Monommata grandis* Tessin (A.B.).
- Sub-family Dicranophorinae.—*Dicranophorus forcipatus* (Müll.) (A.D.E.) *D. rostratus* (D-N and F.) (A.).
- Fam. Synchaetidae.—*Synchaeta gyrina* (Hood) (A.D.E.) *S. kitina* Rousselet (A.B.E.) *S. oblonga* Ehr. (A.B.D.Ex) *S. pectinata* Ehr. (AxBxD.E.) *S. tremula* (Müll.) (AxBxD.E.) *Polyarthra trigla* Ehr. (AxBxDxEx).
- Fam. Gastropodidae.—*Gastropus minor* (Rouss.) (D.) *Ascomorpha ecaudis* Perty (AxBxDx).

Fam. Trichocercidae.—*Trichocerca biscristata* (Gosse) (AxB.D.E.) *T. cristata* (Harring) (AxB.DxE.) *T. elongata* (Gosse) (AxBxDx) *T. longisetata* (Schrank) (AxB.D.Ex) *T. lophoessa* (Gosse) (AxE.) *T. rattus* (Müll.) (AxBxE.) *T. scipio* (Gosse) (D.C.) *T. stylata* (Gosse) (AxB.) *Diurella intermedia* (Stenroos) (AxDxE.) *D. porcellus* (Gosse) (AxBxDxE.) *D. tenuior* (Gosse) (AxBxD.E.) *D. tigris* (Müll.) (A.B.) *D. weberi* (Jennings) (AxBxD.) *Elosa worralli* Lord (A.B.).

Sub-ORDER ASPLANCHNOIDEA.

Fam. Asplanchnidae.—*Asplanchna brightwelli* Gosse (Dx.). *A. priodonta* Gosse (D.).

Sub-ORDER BRACHIONOIDEA.

Fam. Brachionidae.—*Brachionus angularis* (Gosse (D.) *B. calyciflorus* (Ehr.) (D.) *B. quadridentatus* Hermann (D.) *B. rubens* Ehr. (A.D.) *Keratella quadrata* (Müll.) (AxB.D.Ex) *K. stipitata* (Ehr.) (AxBxDxEx) *Notholca foliacea* (Ehr.) (AxB.D.) *N. longispina* Kellicott (B.) *N. striata* (Müll.) (A.B.DxE.).

Fam. Epiphanidae.—*Epiphanes senta* (Müll.) (A.).

Fam. Euchlanidae.—*Dapidia deflexa* (Gosse) (A.D.) *D. pyriformis* Gosse (D.) *Euchlanis dilatata* Ehr. (BxDxE.) *E. macrura* Ehr. (D.) *E. oropha* Gosse (BxDxE.) *E. incisa* Carlin (AxD.) *Lecane flexilis* (Gosse) (D.E.) *L. inermis* (Bryce) (D.E.) *L. luna* (Müll.) (A.Cx) *Monostyla bulla* (Gosse) (A.E.) *Lepadella ovalis* (Müll.) (AxBxDxEx) *L. triptera* Ehr. (A.) *Colurella bicuspidata* (Ehr.) (AxBxDxEx) *Squatinella lamellaris* (Müll.) (A.) *S. longispinata* (Tatem) (A.) *S. mutica* (Ehr.) (A.) *Mytilina mucronata* (Müll.) (AxBxDxEx) *M. ventralis* (Ehr.) (C.) *M. ventralis brevispina* (Ehr.) (Bx) *Trichotria pocillum* (Müll.) (AxB.DxE.) *T. tetractis* (Ehr.) (AxB.D.Ex) *Eudactylota eudactylota* (Gosse) (A.).

Sub-ORDER FILINOIDEA.

Fam. Filiniidae.—*Filinia longisetata* (Ehr.) (D.).

Sub-ORDER TESTUDINELLOIDEA.

Fam. Testudinellidae.—*Testudinella incisa* (Ternetz) (A.B.) *T. mucronata* (Gosse) (A.) *T. parva* (Ternetz) (A.) *T. patina* Hermann (AxBxD.Ex) *T. reflexa* (Gosse) (A.B.E.).

ORDER FLOSCULARIACEA.

Fam. Flosculariidae.—*Floscularia janus* (Hudson) (D.) *F. ringens* (Lin.) (AxD.Ex). *Ptygura crystallina* (Ehr.) (Dx) *P. longipes* (Wills) (Dx) *Sinantharina socialis* (Lin.) (A.).

Fam. Conochilidae.—*Conochilus hippocrepis* (Schrank) (Ax).

ORDER COLLOTHECACEA.

Fam. Collothecidae.—*Collotheca campanulata* (Dobie) (B.E.) *C. ornata cornuta* (Dobie) (E.) *Stephanoceros fimbriatus* (Goldfuss) (A.).

ORDER BDELLOIDA.

Fam. Adinetidae.—*Adineta vaga* (Davis) (A.) *Habrotrocha bidens* (Gosse) (A.D.).

Sub-Fam. Philodininae.—*Philodina citrina* Ehr. (A.D.) *Rotaria macrura* (Ehr.) (AxDxE.) *R. neptunia* (Ehr.) (A.D.) *R. tardigrada* (Ehr.) (A.D.A.) *Dissotrocha aculeata* (Ehr.) (A.D.).

In submitting the sub-joined preliminary list of the forms he has himself encountered during the past three years within a six-mile radius of Cawston, the writer would explain that his personal interest is mainly in the sessile forms of Rotatoria which in the adult stage are permanently attached to water plants. In consequence he does not employ the plankton net extensively, and, therefore, his catches do not include the large collections of free-swimming littoral and planktonic species which form the greater proportion of big hauls reported from time to time.

In the study of the animals, as distinct from the listing of captures, it is highly desirable to specialise in a particular group of related forms, as is done, of course, in other branches of Natural History. In this respect, however, rotiferists in Great Britain appear to be much behind those of other European countries and the United States, and nowhere do workers seem to be much concerned with the habits of the Rotatoria, a subject of the very greatest interest, particularly concerning the various methods adopted by the fixed forms in constructing their tubes and nests.

As an illustration of the advantage of concentrating upon a definite section the writer would with all modesty draw attention to the prominence of rare sessiles in the genera *Floscularia* and *Collotheca* and of hitherto undescribed members of the genus *Ptygura* in his list. These are marked with an asterisk.

STATIONS IN CAWSTON AREA.

- (1) Lake at Haveringland.
- (2) Lake on Cawston Manor estate.
- (3) Lake in Bluestone Plantation.
- (4) Pits at Booton.
- (5) Pool at Heydon.
- (6) Pond near Ingworth.
- (7) Pond near Cawston Village.
- (8) Pond at Ollands Farm, Bluestone.
- (9) Pools on Cawston Heath.
- (10) Horse trough at Marsham.

Order PLOIMA.

- Fam. Notommatidae.—*Proales fallaciosa* Wulfert (8). *Proalinopsis caudatus* (Collins) (9). *Notommata aurita* (Müller) (1, 4). *N. pachyura* (Gosse) (9). *N. forcipata* Gosse (9). *Taphrocampa annulosa* Gosse (2, 4). *Eosphora najas* Ehr. (8). **Alberta intrusor* Gosse (2). *Cephalodella auriculata* (Müller) (1, 2). *C. caeca* (Gosse) (9). *C. gibba* (Ehr.) (4). *C. eva* (Gosse) (4). *C. forficula* (Ehr.) (3). *Scaridium longicaudum* (Müller) (2, 4).
- Sub-Fam. Dicranophorinae.—*Dicranophorus forcipatus* (Müller) (9, 10).
- Fam. Synchaetidae.—*Synchaeta tremula* (Müller) (4, 7). *S. pectinata* Ehr. (1, 2, 7). *S. oblonga* Ehr. (1). **Mikrocodides chlaena* (Gosse) (9). *Polyarthra trigla* Ehr. (2, 7).
- Fam. Gastropodidae.—*Gastropus hyptopus* (Ehr.) (9). *G. stylifer* Imhof (9). *Ascomorpha ecaudis* Perty (4, 9).
- Fam. Trichocercidae.—*Trichocerca cristata* Hanning (1, 2, 4, 5). *T. longiseta* (Schrank) (1). *T. porcellus* (Gosse) (1, 2).
- Fam. Asplanchnidae.—*Asplanchna brightwelli* Gosse (6). *A. priodonta* Gosse (2).
- Fam. Brachionidae.—*Brachionus urceolaris* (Müller) (7, 9). *B. quadridentatus* Hermann (4, 6, 7). *B. angularis* Gosse (7, 9). *B. calyciflorus* (Ehr.) (6). *Platylabus quadricornis* (Ehr.) (8). *Keratella quadrata* (Müller) (2, 7). *K. valga* (Ehr.) (2, 7). *K. serrulata* (Ehr.) (9). *K. cochlearis* (Gosse) (2). *Notholca striata* (Müller) (7). *Anuraeopsis fissa* Lauterborn (2, 7).
- Fam. Epiphanidae.—*Epiphanes senta* (Müller) (9). *E. brachionus* (Ehr.) (9). *Rhinoglena frontalis* Ehr. (7).
- Fam. Euchlanidae.—*Euchlanis incisa* Carlin (2, 4). *E. dilatata* (Ehr.) (1, 2, 3, 7, 10). *Dapidia deflexa* (Gosse) (1, 2). *Lecane luna* (Müller) (2, 8). *L. ludwigii* (Eckstein) (1). *Monostyla lunaris* Ehr. (1). *Lepadella triptera* Ehr. (4, 8). *Colurella bicuspidata* (Ehr.) (4). *Squatinella lamellaris* (Müller) (2, 4, 7). *S. mutica* (Ehr.) (9).
- Fam. Mytilinidae.—*Mytilina ventralis brevispina* (Ehr.) (7, 10).
- Fam. Trichotridae.—*Trichotria pocillum* (Müller) (2, 4, 5, 10). *T. tetractis* (Ehr.) (9). *Lophocharis oxysternon* (Gosse) (2).
- Fam. Filiniidae.—*Filinia longiseta* (Ehr.) (2). *Pedalia mira* (Hudson) (2, 7).
- Fam. Testudinellidae.—*Testudinella patina* (Hermann) (1, 2, 3, 4, 5, 8, 10). **T. bidentata* (Ternetz) (2). *T. patina valvata* (Hudson) (3, 10). *T. reflexa* (Gosse) (3, 4). *T. elliptica* (Ehr.) (4).

Order FLOSCULARIACEA.

- Fam. Flosculariidae.—*Floscularia ringens* (Linnaeus) (1, 2, 4, 5). **F. melicerta* (Ehr.) (2, 4). *Limnias ceratophylli* (Schrank) (1). **L. melicerta* (Weisse) (3). *Ptygura beauchampi* Edmondson (1, 4). *P. melicerta* Ehr. (1, 2, 3, 5, 10). *P. mucicola* (Kellicott) (2, 4). **P. furcillata* (Kellicott) (2, 3). *P. crystallina* (Ehr.) (1, 2). **P. intermedia* (Davis) (1). *P. longicornis bispicata* Edmondson (4, 9). *P. lacunosa*, sp. nov. (1, 4, 5). *P. tridorsicornis*, sp. nov. (1, 2, 4). *P. cephaloceros*, sp. nov. (2, 4). *Beauchampia crucigera* (Dutrochet) (2, 4).
- Fam. Conochilidae.—*Conochilus unicornis* Rousselet (2).

Order COLLOTHECACEA.

Fam. Collotheceidae.—**Collotheca heptabrachiata* (Schoch) (4). **C. algicola* (Hudson) (4). *C. campanulata* (Dobie) (2, 4, 5). **C. campanulata longicaudata* (Hudson) (9). *C. ornata* (Ehr.) (1, 2, 4, 5). *C. ornata cornuta* (Dobie) (4, 5). *C. ambigua* (Hudson) (4, 10). **C. coronetta* (Cubitt) (4, 9). **C. trilobata* (Collins) (9). **C. trifidlobata* (Pittock) (9). *Stephanoceros fimbriatus* (Goldfuss) (2, 4).

Order BDELLOIDA.

Sub-Fam. Philodininae.—*Philodina megalotrocha* Ehr. (1, 2, 4, 5). *P. citrina* Ehr. (1). *Rotaria rotatoria* (Pallas) (1). *R. neptunia* (Ehr.) (7). *R. tardigrada* (Ehr.) (2, 4). *R. macroceros* (Gosse) (1, 2, 10). *R. macrura* Ehr. (9). *Dissotrocha aculeata* (Ehr.) (1, 2, 4). *D. macrostyla* (Ehr.) (9).

Ptygura lacunosa, sp. nov. (Pl. I).

Specific characters: Trochal disc a narrow oval, often contracted to kidney shape, twice width of body and usually carried with the plane of its surface parallel with the long axis of the animal. Dorsal gap of corona very broad, being equal to the width of the body. Dorsal antenna a minute cylinder; ventral antennae cylindrical, one-third width of body and situated on the neck, level with top of mastax. No dorsal hooks. No eyes.

This is one of the smallest of the tubicolous Rotifers, which may have caused it to be overlooked hitherto or mistaken for the early form of some other species. It is mainly to be distinguished from all the other members of the genus by the great width of the dorsal gap, which is half or more than half that of the corona. This means that when the animal is viewed directly dorsally or ventrally the break in the trochal ciliation can be seen on both sides of the neck at the same time. The only other Floscularian so far described as having a dorsal gap equal to the width of the body is *Limnias myriophylli*, which the writer has not seen. The two other members of the genus *Limnias* (*L. ceratophylli* and *L. melicerta*) have broad dorsal gaps, but *Ptygura lacunosa*, though a very much smaller animal, has a dorsal gap whose width not only far exceeds that of the two *Limnias* spp. in a relative sense but is actually equal to that of a half-grown *L. ceratophylli*.

In lateral view the corona appears small and insignificant in proportion to the length of the animal owing to the habit of the Rotifer to contract the organ, causing its depth to approximate only about a third of its width. *P. lacunosa* often

bends backward sharply, making it difficult to see the features of the disc dorsally, but during the brief periods when, after a quick and impatient twist, the animal presents the desired aspect, it affords a charming view of the beautiful little disc, with the whole of the trochal ciliation from start to finish of the course, which delights the observer.

The ventral antennae are placed well up on the neck and are well-developed slightly diverging cylinders, measuring $10\ \mu$ in the great majority of a large number of specimens examined, while in one or two examples they were $14\ \mu$ long. At the junction between neck and trunk there is a fold, which represents the widest part of the body. Excluding this fold or wrinkle, the sides of the animal from just below the corona to the level of the cloaca are more or less parallel.

Ptygura lacunosa is a very active animal, changing its orientation with a jerk, but is not sensitive to normal disturbance. It habitually rises well out of its rough tube, the intestine being usually near or above the top of the nest. Though it contracts at intervals of a few seconds to deposit collections of matter on the pile that thus rises round it, the latter does not appear to become higher than is sufficient to cover the contracted animal. The nest is a more or less conical heap of gritty and floccose material, the upper part being somewhat loose and elastic with a tendency to close upon the withdrawal of the Rotifer.

Ptygura lacunosa was taken in large numbers on *Myriophyllum spicatum* and *Ranunculus aquatilis* from the lake at Haveringland from May to September and occasionally as late as October. Average dimensions: Disc, $50\ \mu$ to $60\ \mu$ wide, $25\ \mu$ to $30\ \mu$ deep. Dorsal gap, $30\ \mu$; neck and body, $30\ \mu$ wide; body at fold joining neck $32\ \mu$ wide; ventral antennae, $10\ \mu$ to $14\ \mu$ long; dorsal antenna very short cylinder. Total length of animal, $180\ \mu$ to $200\ \mu$. Egg, $50\ \mu$ by $26\ \mu$.

Ptygura tridorsicornis, sp. nov. (Pl. II).

Specific characters: Trochal disc sub circular, rather less than twice width of body; dorsal gap one-seventh width of disc. Plane of disc at right angles to long axis of animal but habitually bent over to ventral side. Cervical antenna very short cylinder; pair of similar antennae situated on dorsum.

Setae of all antennae curved posteriorly. No dorsal hooks. No eyes.

This species, which appears to be widely distributed and of frequent occurrence, is distinguished by the position of the paired antennae on the dorsum. They are not readily seen for the animal is small and its antennae are the merest pimples, though the setae are of considerable length. In size and general appearance *P. tridorsicornis* comes nearest to *P. mucicola* (Kellicott) but, unlike the latter, it has no dorsal hooks or hook and is not found in colonies of *Gloeotricha*, and it has a wider disc. It appears to be a solitary species and has been found on various plants, always in large bodies of water and never in ponds.

The bending of the animal's corona and neck to the ventral side seems to be due to a stiffening of the cuticle of the neck—a condition seen very markedly in certain members of the genus *Limnias*, wherein that region becomes an inflexible saddle. In *P. tridorsicornis* this stiffening of the dorsal side of the neck is most noticeable when the Rotifer is in the act of expanding, for as the corona is thrust out the hardened skin of the back of the neck presses the dorsum into a prominent fold or ridge. It is just above that ridge that the paired antennae may be seen if the animal is suitably orientated, below the mastax and midway between the corona and the cloaca. The buccal area is long and forms a steep curve from corona to lip. There is a very extensible foot, much wrinkled transversely. In some examples a segment of the foot just below intestine level formed a stiffened cuff over the part below it. The cloacal orifice pouts permanently perpendicular to the trunk, and in the act of defaecation its only movement is the opening of its external lips. This is characteristic of most sessile Rotifers whose cloaca is above the top of the tube or nest when at rest. In others there is a big displacement of the stomach, intestine and cloaca when excreta is being expelled and the rectum is forced upwards as a long sleeve which delivers the faeces well beyond the top of the tube. This is obviously a provision to prevent the fouling of the habitation. *P. tridorsicornis* does not contract frequently, and, probably in consequence of this, has a very shallow nest, usually amounting to little more than a shapeless collection of mucus and rubbish just sufficient to cover the eggs.

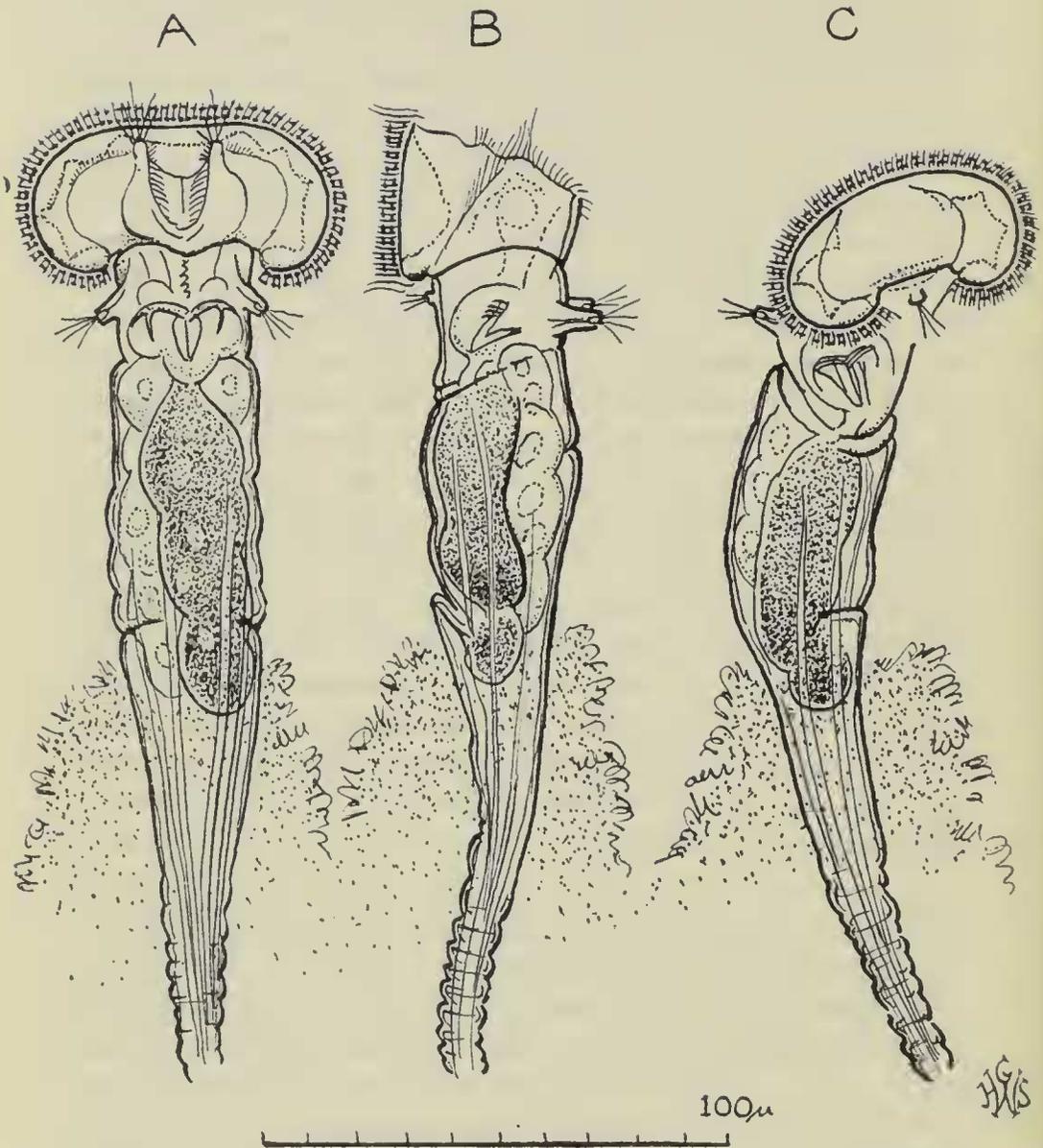


PLATE I

Ptygura lacunosa ♀ sp. nov. A : Ventral aspect. B : Right lateral.
C : Oblique dorsal.

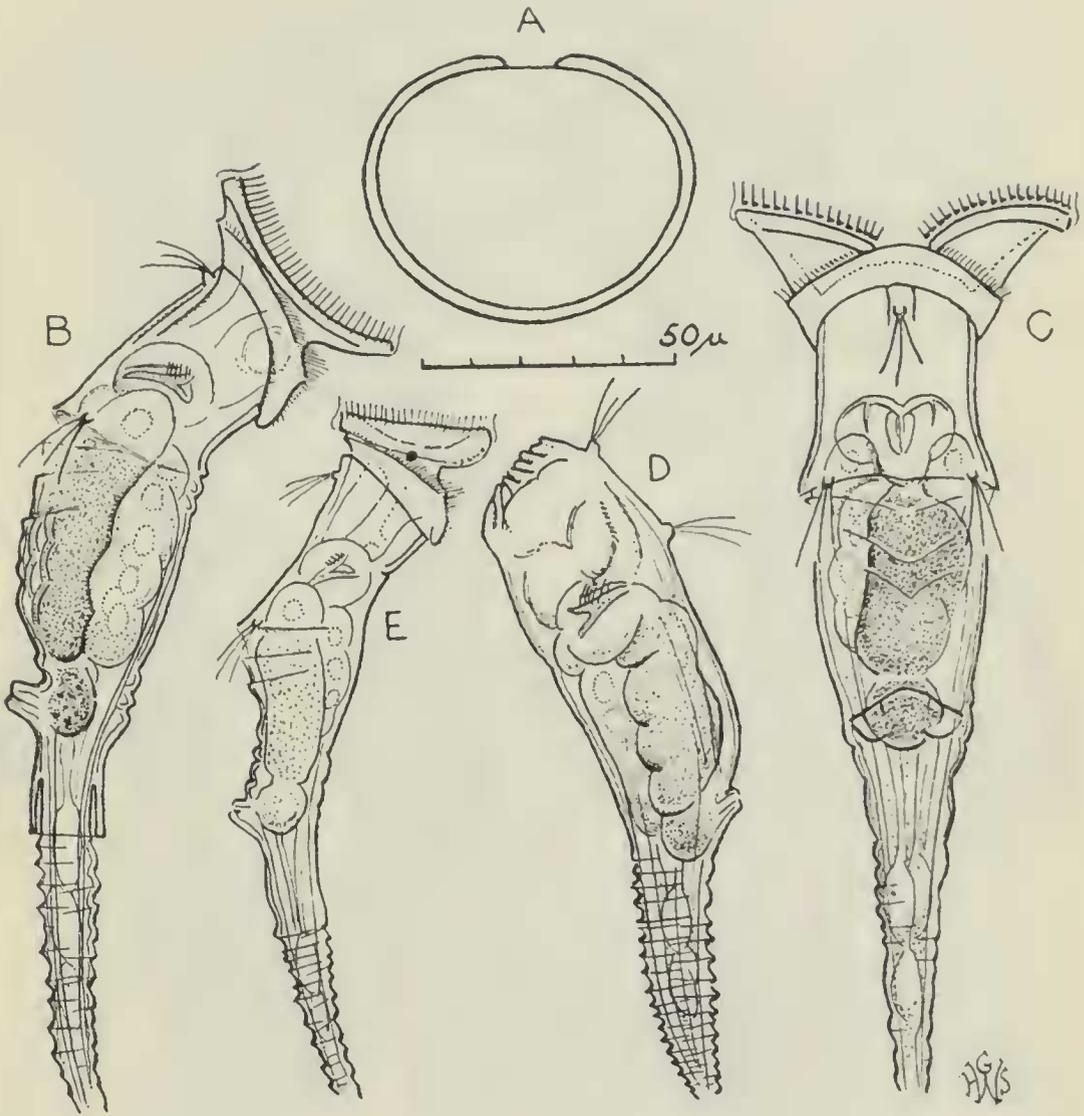


PLATE II

Ptygura tridorsicornis ♀ sp. nov. A: Coronal disc. B: Right lateral aspect. C: Dorsal. D: Contracted adult, left lateral, showing positions of antennae. E: Young animal, right lateral.

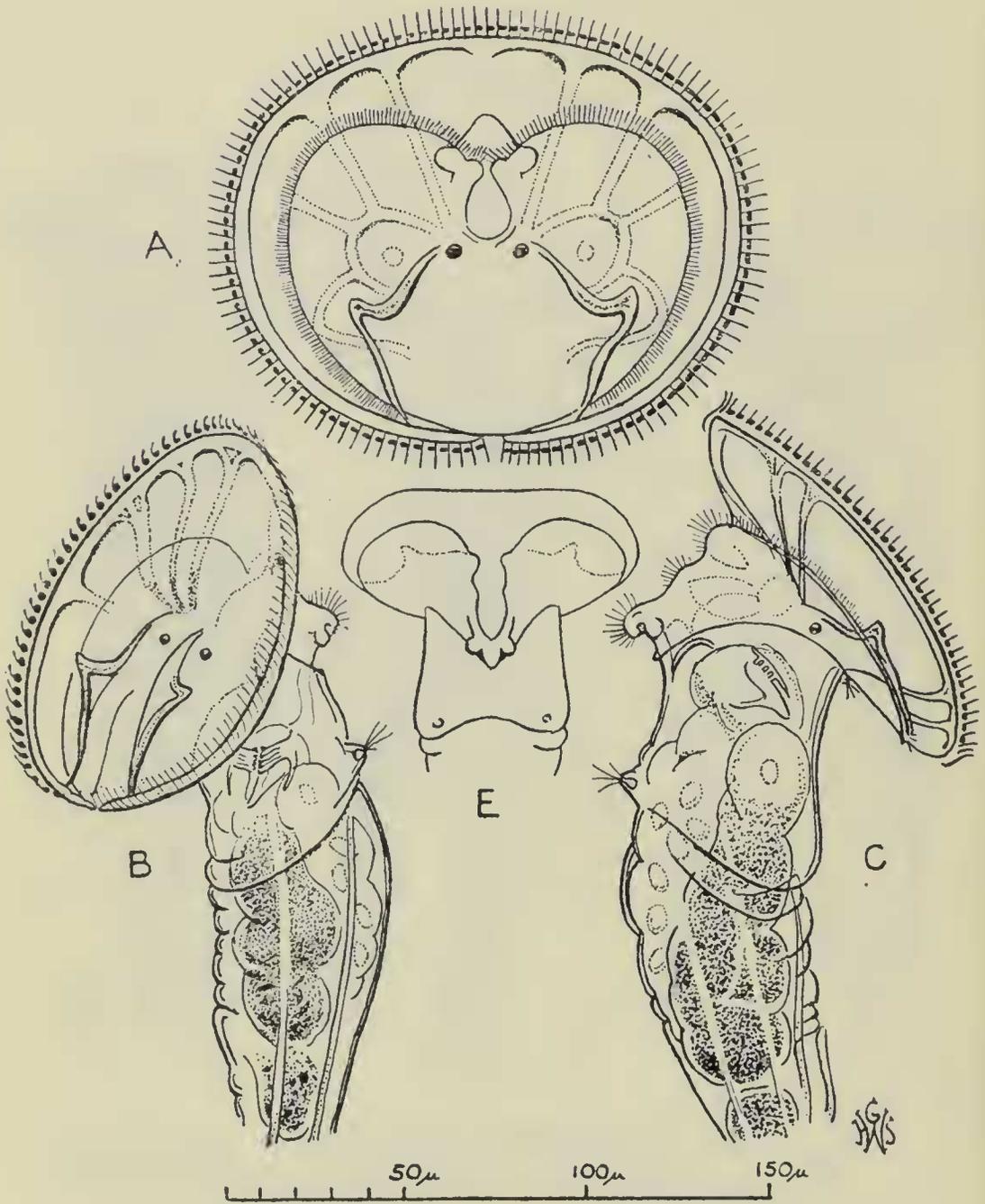


PLATE III

Ptygura cephaloceros ♀ sp. nov. A : Coronal disc. B : Oblique dorsal.
 C : Left lateral. E : Ventral, showing processes on buccal lip.

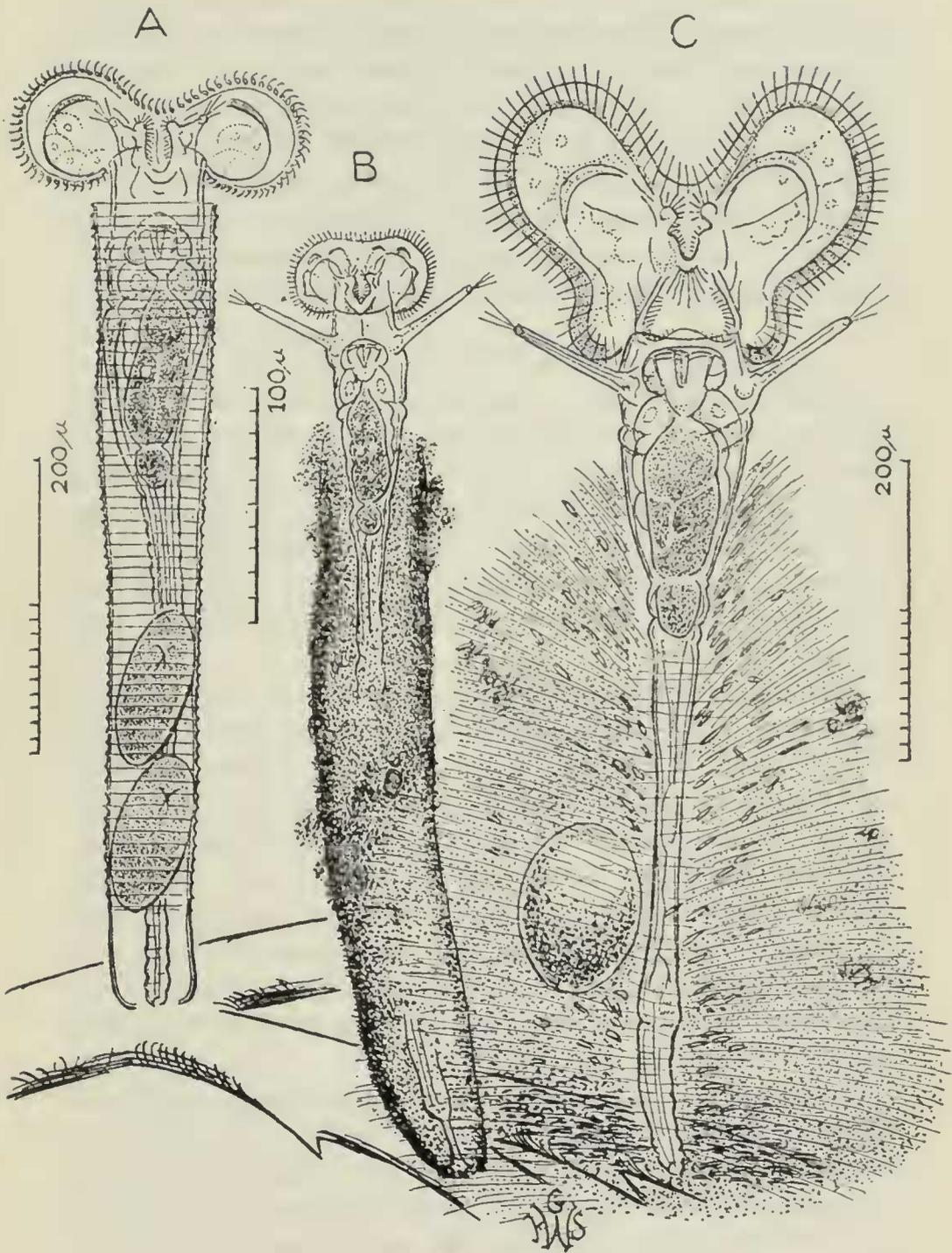


PLATE IV

A: *Limnias melicerta*, ventral. B: *Ptygura longicornis bispicata*, ventral. C: *Floscularia melicerta*, ventral.

It was first found by the writer in the very slightly brackish water of Oulton Broad, Suffolk, in 1948; then from a lake in Calderstones Park, Liverpool, in 1949, and most recently (1953-55) in the lakes at Haveringland and Bluestone Plantation, near Norwich. It occurred chiefly on *Myriophyllum spicatum* and *Ranunculus aquatilis* from May to September.

Average dimensions: Corona 70 μ wide, 54 μ deep; dorsal gap 10 μ ; neck 35 μ wide; body at fold adjoining neck 40 μ ; total length circa 260 μ to 350 μ . Egg 52 μ by 34 μ .

Ptygura cephaloceros, sp. nov. (Pl. III).

Specific characters: Large robust Rotifer with strongly ribbed corona twice or more than twice as wide as the body, carrying near its dorsal edge two prominent stiff transparent eminences each surmounted by a blunt horn-like projection; buccal lip bearing a conical flange on each side; minute dorsal gap; papillose cervical and ventral antennae; two prominent permanent eyes, just below the floor of the corona. No dorsal hooks.

That this really spectacular Rotifer should have escaped notice may well be due to its having been mistaken for *Ptygura velata* (Gosse). This error was committed by the writer in 1941 and was discovered only during the past year when, upon comparing his drawing of the new species with sketches made fourteen years earlier, he realised that the animal he had taken to be *P. velata* was actually that now being described. That first example was found in the author's garden pond in Liverpool, put there unwittingly on some plant transferred probably from one of the fresh water "slacks" or pools on the land side of sand dunes at Freshfield, West Lancashire.

During the summer of 1955 numerous specimens were found on submerged moss in a lake on the Cawston Manor estate and also in the Booton pits, and this material made it possible to study the animal closely. While its comparatively great size and general appearance give it a strong resemblance to *P. velata*, it is to be distinguished at once from that species by the presence on the dorsal moiety of the large saucer-shaped corona of two broad hyaline convexities, one on either side of the median line and extending from the dorsal edge of the corona to its middle. Each of these appears to be supported by curved struts and

carries on its outer edge a prominent subconical projection, bent upwards, outwards and forwards towards the ventral rim of the corona. These are seen most plainly when the corona is viewed laterally or ventrally; they are not so distinct from a dorsal aspect unless dark-ground illumination is employed, in which case they are displayed as two short glistening white lines, and the whole of the really magnificent corona shines like a richly-chased silver shield. There is no indication on the corona of the veiling which led Gosse to give the specific name to his *Ptygura* (= *Oecistes*) *velata*.

Only two other species of *Ptygura* bearing coronal processes of the kind herein mentioned have been described, namely *P. pectinifera* (Murray) and *P. cristata* (Murray). In each of these species the processes are much more highly developed than in the form taken in Lancashire and Norfolk, and Murray's animals are further distinguished by the presence on the ventro-median edge of the corona of a curious comb-like appendage which is particularly marked in *P. pectinifera*. In the species found by the writer there is nothing in the nature of a ventro-median pectinate process. Murray found *P. pectinifera* in a lily pond in Rio de Janeiro and *P. cristata* in a pond in Sydney, forty-three years ago.

It is evident that the new species is in the line of development that has led to the strange forms taken in South America and Australia. The presence of the curious appendages near the apex of the buccal lip brings *P. cephaloceros* a little nearer to *P. pectinifera*, but the two are still well separated morphologically, and, moreover, Murray believed *P. pectinifera* to be a free-swimmer, for "when first caught they swam about very violently," and he never saw a tube.

Ptygura cephaloceros is a sessile tube-builder, but its nest is an amorphous mass of matter which collects under the animal's chin and is brought down to the base by its very frequent contractions. Usually the collection of opaque material conceals all but the corona and the neck, but once or twice the writer saw an animal exposed as far down as the intestine, which occupies the normal position. Measurement of length could not, therefore, be made with any precision, but, assuming the foot of the animal to reach the bottom of the nest, it could in one instance be calculated that the Rotifer was about 400 μ long. This was

the largest of all the examples seen, and its coronal disc was 200 μ from the ventral to dorsal edge. The width of the corona could not be measured because of the position of the animal, but it would be greater than the depth. Its body was 90 μ wide. These measurements compare with Murray's figures for *P. pectinifera* of 130 μ as the width of the corona and 80 μ for the width of the trunk.

Typical dimensions of *P. cephaloceros* found by the writer were: Disc, 140 μ wide, 110 μ deep; body 70 μ wide. One or two had the disc 170 μ wide and 120 μ deep, and the body 80 μ wide. The differences were due to age, but, though the Rotifers did well in shallow receptacles for two months, it was not possible to be sure of the maximum size attainable.

The internal anatomy of this Rotifer appears to be normal. The trophi are strongly developed, with four powerful teeth in each uncus. The first (ventral) tooth on each side has fused with it an accessory tooth whose point rises above the general level. A considerable area in the vicinity of the mastax is strongly tinted with a rusty pink hue. The movements of the trophi are unusually slow and deliberate. In the majority of the *Ptygura* species the action of the jaws is extraordinarily rapid. Judging by the contents of the faeces ejected by *P. cephaloceros*, the animal accepts Diatoms (*Navicula* and *Gomphonema* spp.) as food.

UNCOMMON SPECIES.

Special interest attaches to *Ptygura longicornis bispicata*, Edmondson (Pl. IV, Fig. B) found in the Booton pits and Cawston Heath pool. This very striking Rotifer was first recorded by Professor W. T. Edmondson, of the University of Washington, in 1944, but had not been reported in this country up to the time when the present writer encountered it in a pond in Knowsley Park, Lord Derby's Lancashire seat, in June 1949. The animal was found again at Booton in August, 1955, and on Cawston Heath in January, 1956, in company with a number of other forms which, while less rarely met with than the one now under notice, are not of very common occurrence.

In the writer's view, *bispicata* is a variety of *P. brachiata* (Hudson) rather than of *P. longicornis* (Davis), for it shares several prominent characters with *P. brachiata*, itself very

rare. This is in disagreement with Edmondson, who, however, says he has never seen *P. brachiata*. The drawings given herewith will enable var. *bispicata* to be recognised and no very detailed description is necessary. The animal forms a cigar-shaped tube which may attain a length more than twice that of the Rotifer's body, and in consequence the occupant's foot is very greatly extended in the taller tubes. It has a beautiful corona with a slight ventral indentation and a wide dorsal gap, below which latter two little hooks are plainly to be seen on the upper part of the neck. The ventral antennae are very long cylinders and the foot ends in a fine-drawn peduncle of varying length, though it appears to be longer in the British form than in the American.

In a typical example the body from the ventral edge of the corona to the junction of body and foot measured $100\ \mu$ and the foot $280\ \mu$, the tube being $260\ \mu$ long. The corona was $50\ \mu$ wide, and the length of each ventral antenna $40\ \mu$, i.e., one-third more than the width of the neck.

Another uncommon and handsome sessile taken from the same sources was *Floscularia melicerta* (Pl. IV, fig. C). The generic name is that now applied to the genus formerly known as *Melicerta*, and this alteration is perhaps the most severe of all due to Haring's researches. The change became imperative when he revealed that *Floscularia* was the name given by Cuvier to the famous brick-laying Rotifer in his original description in 1798. Owing to some extraordinary error, this animal came to be known as *Melicerta*, and the name *Floscularia* was misapplied to a very different family, most of whose members secrete mucous nests and bear a crown of setae in place of a wreath of vibrating cilia. Haring gave the "Floscules" the new name of *Collotheca*, which is now in general use.

Floscularia melicerta has borne several names, and one of them, '*Melicerta tyro*,' carried the suggestion that it was not, so to speak, clever enough to build a brick tower like that of the far commoner "*Melicerta ringens*" (now *Floscularia ringens*). The imposing four-lobed corona is similar in both species except for relative size, that of *F. melicerta* being about thrice the width of the body. The outstanding difference between the two is seen in the form of the tube, that of *F. melicerta* being a great

dome of transparent amber-coloured jelly in which an accumulation of Diatoms is usually embedded. Owing to the character of the nest the whole of the animal is visible, whereas under normal conditions *F. ringens* exposes above its brick tower only the corona and the neck as far down as the mastax. *F. melicerta* has the habit of curling the two ventral coronal lobes so that the two dorsal lobes suggest a butterfly.

In place of the pellet-making organ, this animal has a wide gaping cavity from which, especially in young ones engaged in forming a nest, great quantities of mucus are exuded at regular intervals from a gland in the vicinity. The earliest exudations are smeared on the substratum on which the Rotifer rests, and, as the mucus swells greatly in the water, the material soon reaches a considerable height and forms a domed tube. Diatoms and other particles coming in contact with the earliest depositions lie more or less parallel with the substratum, but later ones entering the dome are pulled down by the repeated retractions of the animal and radiate upwards and outwards from the central core occupied by the Rotifer's foot. The whole tube is, furthermore, very faintly striated radially, these evanescent streaks marking the successive layers of mucus. The effect is very pretty and a little puzzling until one has watched the construction of the tube.

This beautiful creature seems now to be very rarely met with, and rotiferists of long experience to whom the writer has sent specimens have declared it to be the most attractive species they have ever seen. It is a comparatively large Rotifer, an adult measuring some 800 μ in total length, and is a magnificent object seen by dark-ground or "opaque" illumination. For exhibition purposes it is ideal, for it is not very timid, and spins its wonderful "wheels" for long periods.

Limnias melicerta (Pl. IV, fig. A), which is seldom recorded, was found in large numbers on *Ceratophyllum demersum* in the Bluestone lake in 1953 and very sparingly in the following year. Since then it has been difficult to find. This Rotifer constructs a tall transparent tube which is beautifully ornamented with rings, the formation of which has caused much speculation. It was the writer's very good fortune to discover that each ring is caused by the deposition of a complete circlet of mucus which hardens while the Rotifer rests with its body

swollen at the mouth of the tube. The first section at the base of the tube is a cuff of plain mucus exuded on the plant by the very small larva, and the ringed additions are built up on this structureless foundation.

The commoner related species, *L. ceratophylli* (found through weeds and rootlets at Haveringland lake) constructs an opaque tube without rings, but here again the first section is laid down as a translucent cylinder excreted by the newly-settled larva.

One of the largest and finest of the Collothecacea, *C. trilobata*, which was found under ice in a Cawston Heath pool early in January, this year (1956) was hailed with particular pleasure, not only because of its great beauty but also on account of its very uncommon occurrence. Only once before (in 1924) had the author seen a specimen, taken from a Cumberland tarn.

In his description of this graceful sessile, Dr. C. T. Hudson wrote (The Rotifera or Wheel Animalcules, 1889): "The first thing that strikes the observer, on watching the protrusion of the furled head, is the great size of the Floscule, and the curiously shrivelled appearance that the lobes of the coronal cup present as they emerge from the opening head. They look exactly as if the animal were sickly or injured. In a few seconds, however, they gently swell out, the many folds and creases disappear, till at last the eye is gratified with the sight of a lovely transparent tulip of three petals, their edges all fringed with delicate motionless hairs."

To this felicitous word picture the present writer can add a note based on his recent observation. When the coronal cup is retracted and the outer cuticle puckered above it, like the tied neck of a sack, the prominent dorsal antenna protrudes well above the puckers, and its spray of setae is plainly visible. This is due to the fact that the antenna, which is very much developed in this species, is not attached to the dorsal lobe but to the cuticular collar which closes over the contracted corona.

From this same pond another uncommon form, *Collotheca campanulata longicaudata* was taken. In most species of the genus the foot ends in a peduncle, either so reduced as to be difficult to see, or, at best, a very short thread; but in *C. campanulata longicaudata* the peduncle is a stiff filament one-third or nearly half the length of the foot, which itself may

be twice as long as the body of the Rotifer. Several published accounts of this species state that the peduncle is thrown into coils or loops when the animal retracts, but in the Cawston Heath specimens the terminal thread does no more than flex slightly, no matter how violent the contraction of the body.

C. campanulata longicaudata is in other respects very like *C. campanulata*, having five spatulate lobes, but it is larger and of a more robust build, and when fully expanded presents (to the mundane mind) the appearance of a standard lamp, once so popular an ornament of our drawing-rooms.

The examples of *Collotheca coronetta* found at Booton and, in larger numbers, in a Cawston Heath pool, make it evident that there are two forms of this elegant Rotifer. Charles Cubitt, who was the first to find, describe and depict it, in 1869, likened its corona (with five long, slender erect lobes, each bearing a tuft of setae) to a coronet. He laid stress on another character in the following words: "In the dorsal lobe the thickened rim is produced at its base into a rounded process at both angles, from each of which radiates a tuft of setae approaching in length those on the anterior knob."

Hudson and Gosse, whose monograph appeared twenty years later, and who were, of course, fully acquainted with what Cubitt had written and drawn (they borrowed one of his diagrams), made no mention of the paired tufts of setae, and did not show them in their figures. Dr. E.-F. Weber, in his "*Faune Rotatorienne du Bassin du Léman*" (1898) says he looked for these tufts and failed to see them. There is a brief description of *C. coronetta* by Dr. A. Collin in "*Süßwasserfauna Deutschlands*" (1912), but no reference to the basal tufts, and the character is similarly ignored in more recent papers and keys. Drawings by Weber and later observers show an animal with shorter and thicker lobes than those illustrated by the original describer, and in a private communication Herr Kurt Wulfert states that this form is very common in Germany.

The present writer has seen Cubitt's animal, two fine examples of which were found in different seasons in Cheshire ponds, and so can compare it with the species or sub-species encountered in the Cawston area, which has shorter thicker lobes and no paired tufts on the dorsal lobe. The latter form, which occurred during the Autumn and winter months, appears to

agree perfectly with the various accounts and illustrations published since Cubitt's time. It would seem that the type species is of rare occurrence and that the short-lobed form has been widely and mistakenly accepted as being the animal discovered by Cubitt.

The encounter with *Collotheca trifoldata* on *Sphagnum* in Cawston Heath water is of interest. This small five-lobed sessile, distinguished by two groups of radiating cilia and a finger-like process on the dorsal lobe, was discovered by Dr. George M. Pittock in the Minster Marshes, Thanet, in 1895. Wulfert found it in a Schneeberg sphagnum bog in July, 1941, and this was believed to be the first record since Pittock's days. It would seem that the present Norfolk appearance is only the third to be reported. Unfortunately, however, the occurrence in this country of uncommon Rotifers does not become known so readily as does that of rare birds and plants, for amateur students of microscopic pond life are not a very numerous or well-organised company, and they are not greatly given to publishing their results.

For the privilege of taking samples from the lakes on the Cawston Manor and Haveringland estates the writer makes his grateful acknowledgment to Lieut.-Colonel H. McDougall and Mr. J. W. Underwood respectively.

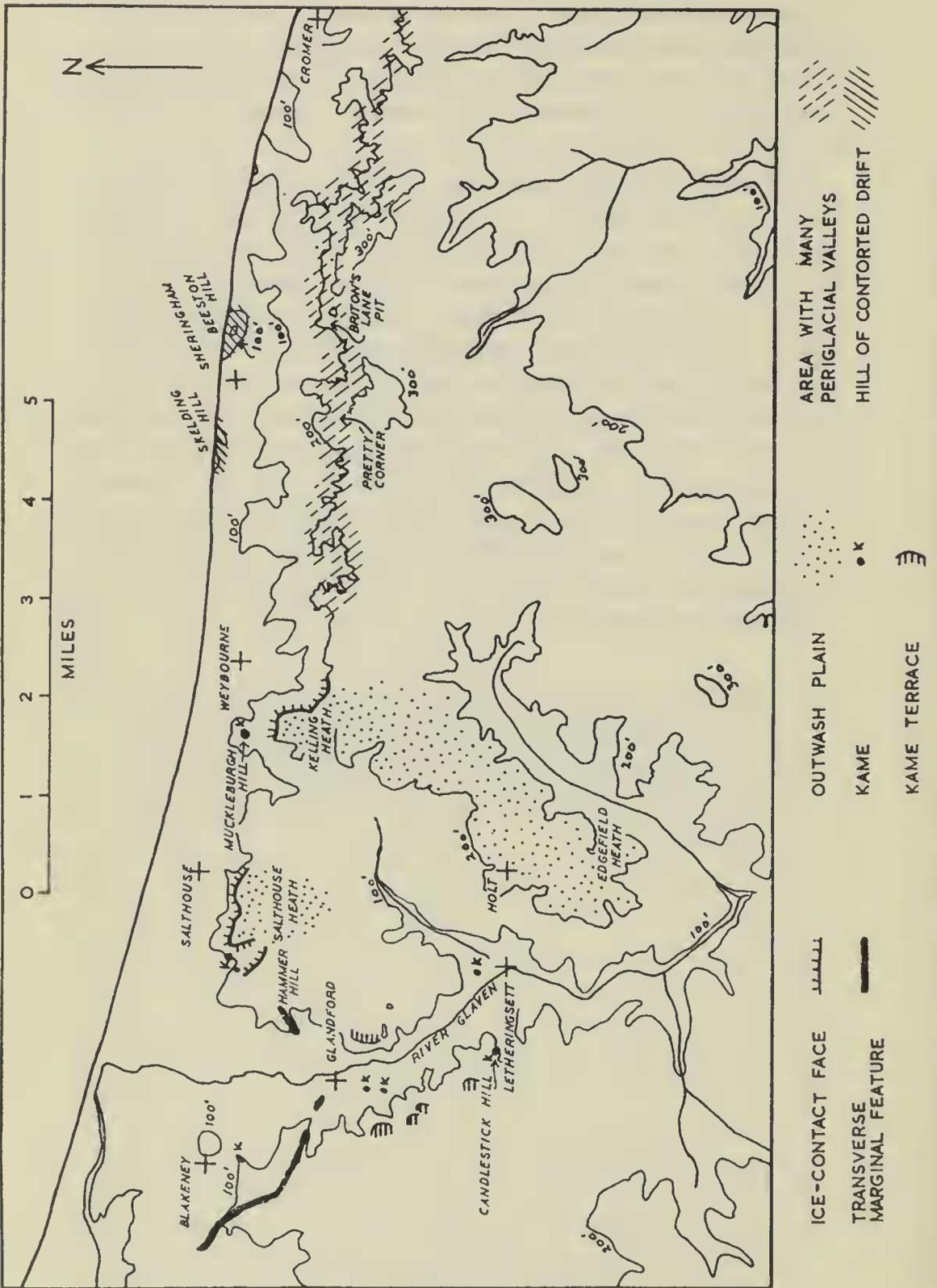


FIGURE 1. Sketch-map of some features of the drift topography around Holt and Cromer.



Crown Copyright Reserved—Reproduced by permission of Air Ministry.

FIGURE 2. Aerial photograph of the north-west part of Salthouse Heath. On the west is the Cley—Holt road. The photograph shows the position of termination of an ice-lobe against Salthouse outwash plain. The ice-contact face is formed by the east slope of the Hangs on the left, and the west slope of Scrib Hill on the right. Great Hulver Hill, interpreted as a kame, is seen at the top centre. The outwash plain, Salthouse Heath, is seen at the bottom right.



Crown Copyright Reserved—Reproduced by permission of Air Ministry.

FIGURE 3. Aerial photograph of the country around Pretty Corner, a mile south of Sheringham. The village at the top left is Upper Sheringham. The photograph shows the northern slope of the Cromer Ridge dissected by periglacial valleys.

NOTES ON A PRELIMINARY MAP OF SOME FEATURES OF THE DRIFT TOPOGRAPHY AROUND HOLT AND CROMER, NORFOLK.

BY R. G. WEST

This short description of drift topography around Holt and Cromer contains some preliminary results obtained from a survey of the drift in the area. The aim of the survey is to provide some clarification of the drift sequence itself, and an analysis of the topography has been undertaken as a first step towards this end. The stratigraphical sequence is not considered here at all, apart from indications of relative age to be gained from the topographical study.

The description of the topographical features shown on the map, figure 1, is best accomplished by grouping them according to their origin and giving a short account of each group. It is hoped that all the forms taken by the drift, except the subdued areas of ground-moraine, will fall into one or other of the groups to be noted.

The location of the features mentioned is shown on the map. It is emphasised that the map is only of a preliminary nature, intended to give a general idea of the diversity of the glacial and periglacial land-forms within the area.

OUTWASH PLAINS (SANDURS) AND ASSOCIATED KAMES.

The two outwash plains shown on the map, one forming Kelling Heath, the other Salthouse Heath, are amongst the most outstanding features of the drift topography in the area. Both have clear and steep proximal ice-contact slopes facing towards the north, and from these the plains slope gently southwards.

The KELLING OUTWASH PLAIN has a marked proximal apex, Telegraph Hill, reaching a height of rather over 250 ft. O.D. From this apex the plain slopes away to the south, forming the heath which extends past Holt, about three miles south, as far as Edgefield Heath. The few good sections in the plain show that it is built up by bedded sands and cannon-shot gravels. As might be expected, in the distal part of the plain the sands appear to predominate, as for example in the large sand-pit near Edgefield Hall.

Immediately north of the proximal ice-contact slope and apex of the Kelling outwash plain is Muckleburgh Hill, a steep-sided and rather conical hill which seems best interpreted as a kame formed headward of the main outwash body.

The SALTHOUSE OUTWASH PLAIN, seen on Plate 1, figure 2, is smaller than the Kelling plain and has a less simple proximal arrangement. Bard Hill and Scrib Hill appear to form apices of the plain. The Hangs, just west of Scrib Hill, forms a small marginal outwash feature bounding an ice-lobe which lay between it and Scrib Hill. The southern margin of the lobe joins the level of the outwash plain. The height reached by the proximal parts of the plain is rather over 200 ft. O.D. Great Hulver Hill, just north of Scrib Hill, and the small hill immediately west of Great Hulver Hill, appear to be kames formed headward of the main outwash body.

KAMES.

In addition to the kames already mentioned in connection with the outwash plains, there are several isolated features of this type, particularly in the River Glaven valley. Here there are numerous gravelly hummocks occurring within the valley itself. One of the best examples is Candlestick Hill, about half-a-mile due west of Letheringsett.

Sections in the hummocks show uncontorted ice-contact and outwash sands and gravels. This, with the orientation of the long axes of the hummocks, suggests they are marginal or near-marginal ice-contact features.

The kames, with their undisturbed sands and gravels, are not to be confused with the hummocks of contorted drift described later.

KAME TERRACES.

Bordering the upper slopes of the River Glaven valley between Letheringsett and Glandford are a series of terrace-like features composed of sand and gravel. These appear to be kame terraces, formed marginally to valley ice.

TRANSVERSE MARGINAL FEATURES (END-MORAINES).

The Blakeney Ridge is here tentatively interpreted as a transverse marginal outwash feature, indicative of a short

standstill of the ice. The Ridge extends from Morston Downs, west of Blakeney, over the divide eastwards to Glandford, in the River Glaven valley. On the east side of this valley the Ridge appears to continue at Hammer Hill. The symmetry of the whole suggests a lobe of ice in the Glaven valley. Such a lobe would block the valley and the Ridge would be formed in standing water. The small size of the Ridge suggests that the blocking did not last for long.

In connection with the direction of water movement during the formation of the Ridge, we may note that the dip of the well-bedded sands and gravels seen in the pit where the main coast road cuts Morston Downs is towards the north and west, and that a small delta is found south of a gap in Hammer Hill, showing the drainage here to have been southwards.

OTHER OUTWASH FEATURES.

Here we consider the form taken by the outwash gravels seen in the Cromer Ridge behind Sheringham. The gravels are well-exposed at the Briton's Lane pit, the type section for the Briton's Lane gravels of Baden-Powell and Moir (1942). In the present sections the gravels are seen to form a terminal outwash feature. The direction of dip of the gravels is towards the north-east and their connection with ice-contact gravel is seen in the south-west part of the pit. The abrupt termination of the feature towards the north-east suggests either that the outwash was built up against an ice-wall or that the deposit is a sub-aqueous delta formed in an ice-ponded lake.

HILLS ASSOCIATED WITH CONTORTED DRIFT.

The contortions seen in the cliff sections have a complex origin. As mentioned by Slater in Boswell and Slater (1923), two causes can be distinguished, each associated with end-moraine formation. The first is the melting of dead ice, causing the slumping of englacial and supraglacial material; the second is contortion of sediments by ice-push, to form the kind of end-moraine known as a push-moraine.

It is thus remarkable that no trace of a landscape which would be produced by melting of dead ice remains in the area of outcrop of contorted drift. All that is seen in the coastal topography are hills composed of very contorted drift lying in a

generally flat landscape. Such hills are Skelding Hill and Beeston Hill, west and east of Sheringham. These hills appear to be remnants of a push-moraine, which have escaped a general levelling of the surface.

PERIGLACIAL VALLEYS.

The steep northern slopes of the Cromer Ridge east of Weybourne, as well as some steeper parts of the southern slope of the Ridge in the same area, are furrowed by numerous steep-sided and usually short valleys (Plate 1, figure 3). The presence of these valleys is shown well on the map by the crinkly contours which result from them. The valleys are absent or less well-developed on the Ridge slopes west of Weybourne.

These valleys are erosion features and thus are not associated with the glacial origin of the Cromer Ridge deposits. The valleys may have first arisen as a result of spring-sapping at the junction of the permeable sands and gravels of the Ridge with the impermeable marly drift which lies beneath. The presence of springs at the heads of some of the larger valleys suggests such an origin. But although this may have been the primary cause of the valley formation, there is no doubt that the erosion has been much accentuated in such a way as to produce the very close distribution of valleys seen at the present day. This accentuation is ascribed to rapid erosion of permeable deposits through phenomena associated with a periglacial climate. With a frozen subsoil, the frequent and periodic melting of surface snow and ice would result in rapid erosion. Valleys of a similar kind found in the sandy push-moraine of the Veluwe in the Netherlands have been given the same explanation by Maarleveld (1949).

SOME OTHER CONSIDERATIONS.

The extent to which deposition and erosion have contributed to the formation of the Holt—Cromer landscape will have been indicated by the foregoing notes. Certain of the features suggest a young glacial landscape, others a glacial landscape modified by much erosion. It is notable that, despite the presence of glacial forms associated with end-moraine formation, there is a complete absence of any real dead-ice topography; for example there are no kettle holes—those enclosed

hollows resulting from the melting of dead ice. Thus the features described are separated by subdued ground-moraine areas.

The size of the different terminal features probably reflects differences in the length of time of the ice standstills forming the features. The period of standstill which resulted in the formation of such a large outwash body as the Kelling outwash plain must have been considerable, while the period of standstill at the Blakeney Ridge seems to have been rather short.

The drainage of any ice-front standing against the coastal region would have been towards the south. While no obvious spillways in this direction are seen, there are low cols in the watershed between the drainage basins north and south of the Cromer Ridge. One is found east of Briston at the head of a tributary valley which joins the River Glaven where the course of that river turns abruptly north-west from the south-west direction of its upper reaches.

Some idea of the relative age of the features forming the Cromer Ridge may be obtained from noting the distribution of the periglacial valleys. It seems that the eastern part of the Ridge, deeply incised by these valleys, is considerably older than the western part, where the valleys become rare or absent. The dividing line appears to be somewhere near the eastern border of the Kelling outwash plain, about due south of where the Contorted Drift rises to form the cliffs east of Weybourne. Thus the Kelling outwash plain and the features west of it seem younger than the features displayed by the eastern part of the main Cromer Ridge.

Finally, we can clearly conclude that the features described here indicate a very complex history of the ice movements which resulted in the building-up of the Cromer Ridge.

REFERENCES.

- Baden-Powell, D. F. W. & Moir, J. R., 1942, "On a New Palaeolithic Industry from the Norfolk Coast," *Geol. Mag.*, 79, 209.
- Boswell, P. G. H. & Slater, G., 1923, "Whitsuntide Excursion to the Cromer and Norwich districts," *Proc. Geol. Assoc.*, 34, 223.
- Maarleveld, G. C., 1949, "Over de erosiedalen van de Veluwe," *Tijdschrift van het Kon. Nederlandsch Aardrijkskundig Genootschap*, 66 (2), 133.

SENECIO SQUALIDUS L. IN THE BRITISH ISLES—3,
EAST ANGLIA.

BY DOUGLAS H. KENT.

The spread of *Senecio squalidus* in East Anglia presents a complex problem for it appears unlikely that it has travelled via the railway from Oxford. It was known as a deliberate introduction in E. and W. Suffolk and E. Norfolk in the mid-19th century (Kent, 1956), and it is probable that the slow spread of the species has originated from these localities, namely Gorleston, Bury and Norwich. In 1884 it was reported at Yarmouth, E. Norfolk, where it had doubtless spread from Norwich, and in 1918 from Lowestoft, E. Suffolk. During 1924 it was noted from Oulton Broad, E. Suffolk. Simpson (1936) recorded it as common about the goods yard and electric power station at Ipswich and the pier station sidings at Felixstowe, E. Suffolk. Just prior to the outbreak of the Second World War it was found to be abundant in the Chesterton and Milton region on the outskirts of Cambridge (S. M. Walters in litt.). During 1939 it was gathered by the roadside near Lakenheath Warren, W. Suffolk and King's Lynn Docks, W. Norfolk (E. L. Swann in litt.).

It will be seen that the advance of the plant over the East Anglian countryside was much less spectacular than the rapid spread from Oxford and even at the end of the war it was still very local in occurrence. That the plant was increasing in its established stations was however confirmed by Long (1945), who wrote "now waste spaces [at Lowestoft] but partially cleared after enemy bombing are gay with masses of *Epilobium angustifolium* and *Senecio squalidus*, both unknown in the town five and twenty years ago." In 1946 it occurred at Mildenhall, W. Suffolk, but did not persist (Simpson, 1953), along railway banks north, south and east of King's Lynn and at Bawsey, W. Norfolk (E. L. Swann in litt.), also from the centre of Cambridge and from Peterborough and March, Cambridge (S. M. Walters in litt.). Simpson (1953) outlined its known distribution in W. Suffolk adding the following new localities:—between Ipswich and Bury at Claydon, Stowmarket and Haughley; Woodbridge and Melton. He also confirmed that the plant was

rapidly spreading along the railways and was plentiful and increasing at Lowestoft, Yarmouth, Ipswich, Bury and Felixstowe. During 1954 it was noted at Bungay, E. Suffolk (T. G. Collett) and by the railway at Holt, E. Norfolk in plenty (K. E. Bull in litt.). In conclusion I noted it in 1955 growing in a sandpit at Wymondham, E. Norfolk.

The following exsiccata supporting the records given above have been seen by the author except where otherwise stated (see also Kent, 1956).

V.c. 25, E. SUFFOLK. Bombed site, Lowestoft, 1946, *W. B. Turrill*, Hb. Kew.

V.c. 26, W. SUFFOLK. Roadside near Lakenheath Warren, 1939, *A. S. Watt*, Hb. Cantab., teste *Dr. S. M. Walters*.

V.c. 27, E. NORFOLK. Yarmouth, 1884 and 1888, *E. F. Linton*, Hb. Mus. Brit., Wall of Yarmouth Churchyard, 1901, *S. H. Bickham*, Hb. Cantab., teste *Dr. S. M. Walters*. Great Yarmouth, 1931, *E. A. Ellis*, Hb. Druce.

ACKNOWLEDGMENTS.

I am greatly indebted to Dr. E. F. Warburg for the loan of material from Hb. Druce ; to Dr. S. M. Walters for information on *S. squalidus* in Cambridgeshire, and for records from Hb. Cantab., and to Mr. E. L. Swann for details of the plant in W. Norfolk.

REFERENCES.

- DEACON, G. E., 1943, "Early history of *Senecio squalidus* in Norfolk," *Trans. Norfolk & Norwich Nats. Soc.*, 15, 425.
- HIND, W. M., 1889, *Flora of Suffolk*.
- KENT, D. H., 1956, "*Senecio squalidus* L. in the British Isles—1. Early Records (to 1877)", *Proc. Bot. Soc., Brit. Isles*, 2, 115-118.
- LONG, E. R., 1945, *Trans. Suffolk Nats. Soc.*, 5, 211.
- NICHOLSON, W. A., 1914, *Flora of Norfolk*.
- SIMPSON, F. W., 1936, *Trans. Suffolk Nats. Soc.*, 3, 130 ; 1953, *Trans. Suffolk Nats. Soc.*, 8, 3-4.



Norfolk & Norwich Naturalists' Society

Patron :

HER MAJESTY THE QUEEN.

President : 1956-57 : E. L. SWANN.

Hon. Secretary : F. J. TAYLOR PAGE, 77, Surrey Street, Norwich.

*Hon. Assistant Secretary : MISS R. M. BARNES, Castle Museum,
Norwich.*

Hon. Treasurer : E. T. DANIELS, 352, Dereham Road, Norwich.

MEMBERSHIP.

A candidate for membership may be proposed and elected at any meeting of the Society. The rates of subscription are: for an Ordinary Member, 15/- ; for a Family, 25/- ; and for a School Group of six pupils, 2 guineas. Forms of application may be obtained from the Secretary. Subscriptions become due annually on 1st April.

PUBLICATIONS.

Papers on Norfolk Natural History intended for publication in the *Transactions* should be sent to the Hon. Editor, E. A. Ellis, Wheatfen Broad, Surlingham, Norwich and should be typewritten. Short papers and notes for inclusion in a Miscellany should be submitted by 31st May, 1957.

Members are reminded that the annual *Norfolk Bird Report* is in each case a numbered *Part* of the *Transactions*, as is indicated on the *inside* of the front cover.