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STUDIES ON THE GENUS *DICRANOCENTROIDES* IMMS (1912) [COLLEMBOLA ENTOMOBRYIDAE PARONELLINAE] FROM INDIA

By

S. K. MITRA

Zoological Survey of India, Calcutta

(With 20 text-figures and 1 plate)

INTRODUCTION

The genus *Dicranocentroides* was established by Imms (1912) from India with the type-species *D. fasciculatus*. Examination of further collections from various parts of India indicates, (i) the form of *D. fasciculatus, viz., flavescens,* described by Yosii (1966), is an independent species, (ii) *Aphysa indica* Handschin (1929), is a good member of the genus *Dicranocentroides* and (iii) existence of two new species. All these species are now described from the modern taxonomic stand-point.

SYSTEMATIC ACCOUNT

Besides the collections, represented in the Zoological Survey of India, the author had also an access to a syntype of *D. fasciculatus* Imms and other material of the genus from the British Museum (Natural History), London.

The concept of dorso-ventrality of furcula, accepted in this investigation, is after Handschin (1925) and that of the subdivisions of head is after Yosii (1956) In this study, area parietalis is further subdivided into two subregions, *viz.*, area postocularis and area parietails ; setae in these regions are designated by 'Po' and 'P' respectively. Notations used to designate seate in each region are by capital letters for macrochaetae and small letters for microchaetae.

Descriptions of the species

1. **Dicranocentroides fasciculatus** Imms

(Text-figs. 1-6 ; plate 1, A)

1912. *Dicranocentroides fasciculatus* Imms, *Proc. zool. Soc., London*: 80-125.

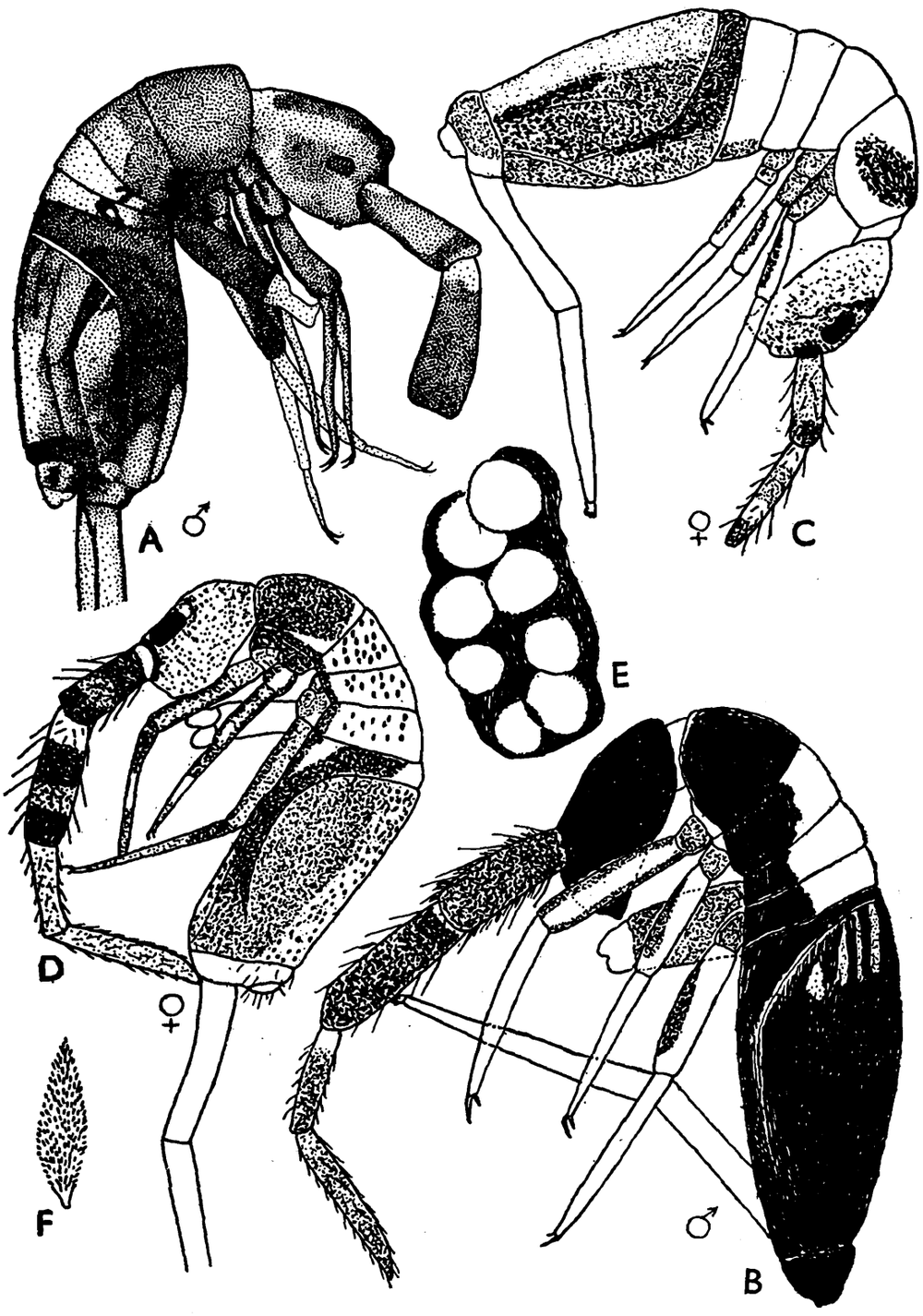
1917. *Paronella crassicornis* Carpenter, *Rec. Indian Mus.*, Calcutta, **8**: 561-568, new synonymy.

1925. *Dicranocentroides fasciatus*: Schött, *Sarawak Mus. Jour.*, **3**: 107-127 (lapsus for *fasciculatus*).

Material.—1 syntype from the British Museum (Nat. Hist.), London ; Uttar Pradesh, India—Lansdowne, Pauri Garhwal Dist., 17.iii.1965, 4 exs. ; Sahasradhara Hills, Dehra Dun Dist., 5.x.1964, 26.xi.1964, 22 exs.—all collected by *S. K. Mitra.*

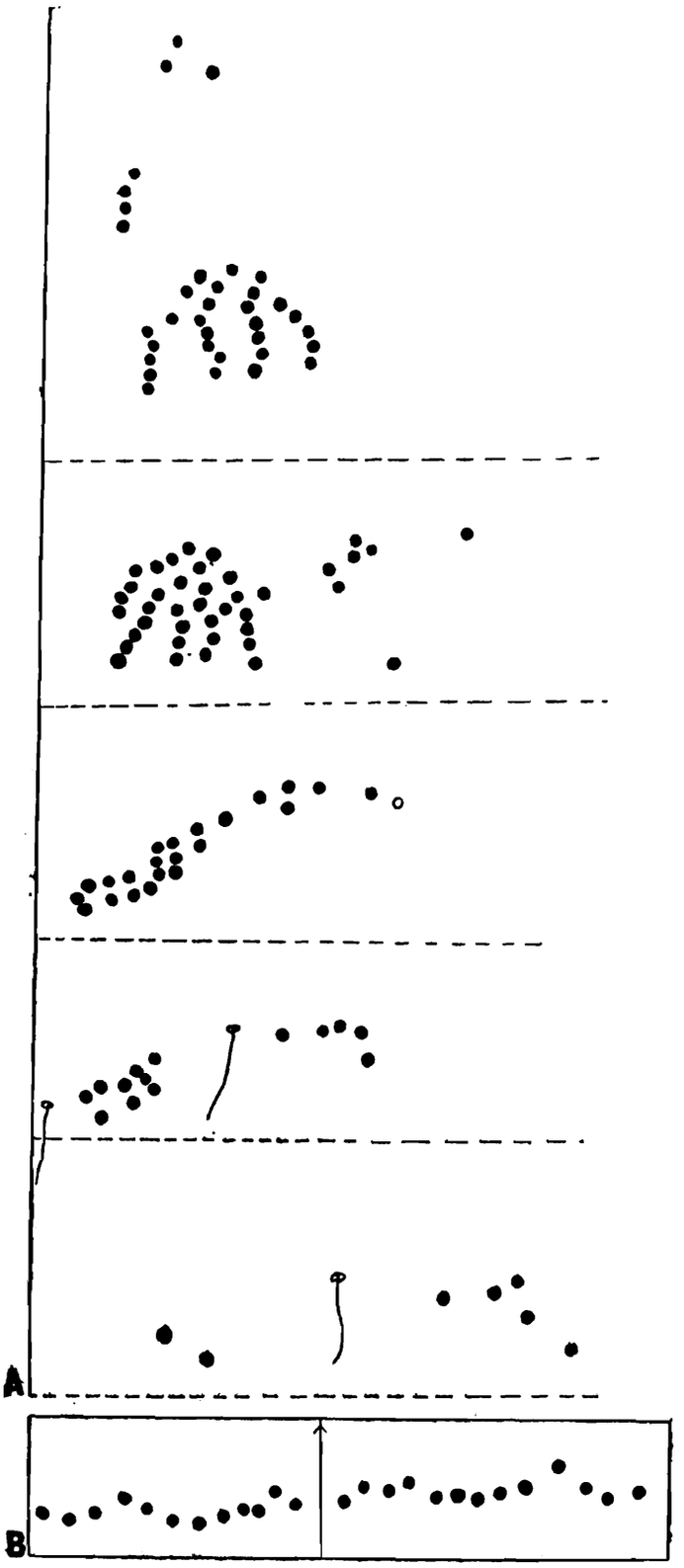
Colouration.—Males largest, darkest ; females lighter, smaller than males ; Abds. III, IV, V usually dark brown, Abds. IV, V sometime paler ; Th. II always with reddish to brown pigment, in males such pigment extends all over Th. II, while in females usually disposed as patches ; pigment restricted to lateral margins on Th. II, Abds. I, II : in males, such lateral pigmentation (band) very dark and extensive, while in females, pale and restricted merely to margins of tergites and may be absent ; mid-dorsal regions of Th. III, Abds. I, II pale yellow in spirit [before preservation in spirit, these regions including head often shine with golden metallic iridescence] ; head usually dark pigmented in males, lighter in females (Text-fig. 1, A, D) ; antennae with similar nature of pigment as that of body ; in males, Ants. I, II darker along their entire length, while in females the median region of Ants. I and II pale ; coxae, trochanter and femur in majority of the examples pigmented ; tibiotarsi with or without pigment.

Clothing.—Clothed with pseudoscales of various shapes and sizes, which may be from lanceolate to those with secondarily truncated or round apices ; macrochaetae darker, obliquely truncated, number and arrangement of which on each segment asymmetrical and variable ; for example, specimen—I (Text-fig. 2, A) : Th. II (including 4 median setae and excluding those on anterior margin), 32/33 ; Th. III, 40 ; Abd. I, 22/23 ; Abd. II, 14/15 ; Abd. III, 7 (setae on lateral extension not taken into consideration) ; specimen-II (Text-fig. 3) : Th. II (including 4 median setae and excluding those on anterior margin), 37/44 ;



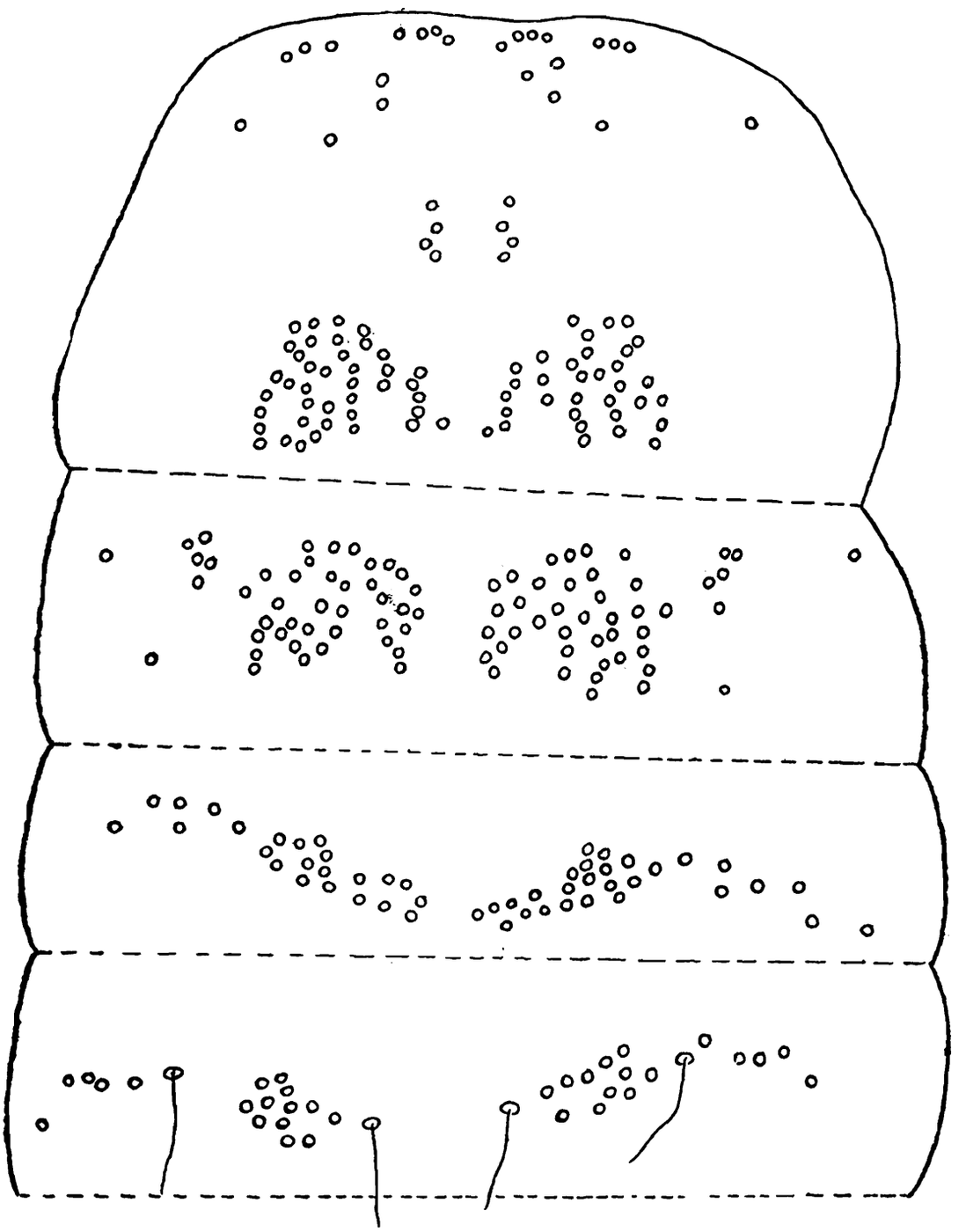
Text-fig. 1. Profile of *Dicranocentroides fasciculatus* Imms. A. Lectotype [now designated and present in the Brit. Mus. (Nat. Hist.), London ; see also photomicrograph on Pl. 1, A] ; B, C. Specimens from Sahasradhara, Dehra Dun, U.P. ; D. Specimen from Lansdowne, Pauri Garhwal, U.P. ; E. Arrangement of ocelli ; F. A pseudoscale from body.

Th. III, 43/44 ; Abd. I, 23/28 ; Abd. II, 16/17 ; specimen-II (Text fig. 4, C) : Th. III, 35/37 ; Abd. I, 27/26 ; Abd. IV medially



Text-fig. 2. Chaetotaxy of *Dicranocentroides fasciculatus* Imms. A. Ths. II, III/Abds. I, II, III (specimen I); B. Arrangement of the transverse row of macrochaetae medially on Abd. IV.

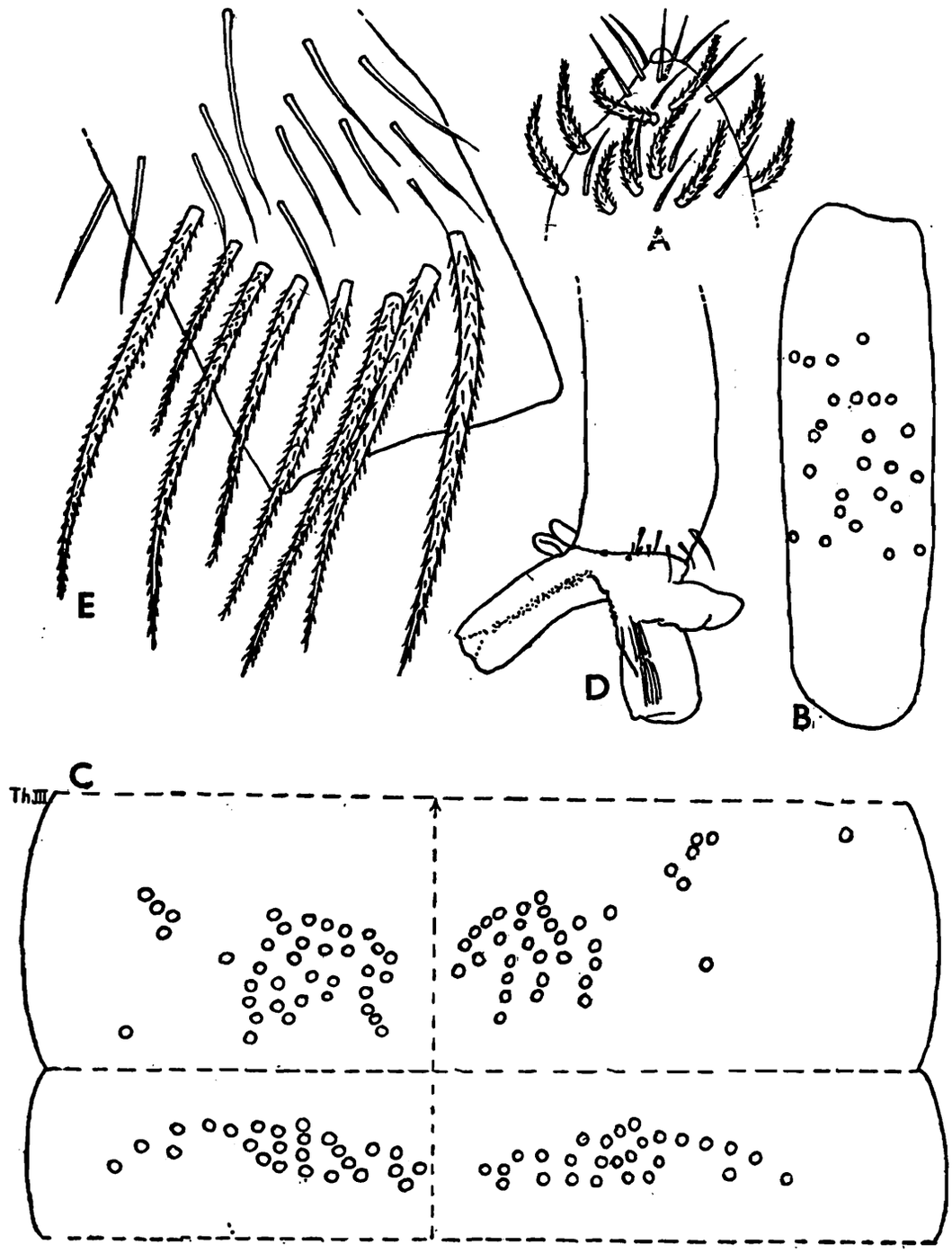
with 12/13 macrochaetae on each side, fairly constant in most of the examples examined (Text-fig. 2, B); Ant. I with at least 25 stiff dark brown macrochaetae, arrangement as in Text-fig. 4, B;



Text-fig. 3. Chaetotaxy of *Dicranocentroides fasciculatus* Imms. Ths. II, III/Abds. I, II (specimen II); note asymmetry and variation in the number and arrangement of macrochaetae.

head : vertex with $V_0 + V_{1-7}$; subdorsal region represented by sd_{1-13} ; dorsal region with d_{1-6}, d_{1-3} unpaired ones located on mid-dorsal line and D_6, a macrochaeta ; ocular microchaetae $3(oc_{1-3})$; post ocular region with single macrochaeta (PO_1) ; occipital region with single variable microchaeta (O_1) and a macrochaeta (O_2) ; genal region with 2 macrochaetae on each side (G_{1-2}) (Text-fig. 6).

Head.—Pear-shaped, when viewed from above ; 1 + 1 dark ocellar field, each field containing 8 ocelli, arranged in 2 longitudinal parallel rows, ocelli G and H smaller than the rest (Text-fig. 1, E) ; antennal length variable, usually subequal to body ; Ant. I subequal or a little longer than Ant. III, Ant. IV subequal



Text-fig. 4. *Dicranocentroides fasciculatus* Imms. A. Apex of Ant. IV; B. Chaetotaxy of Ant. I; C. Chaetotaxy of Th. III/Abd. I showing asymmetry and variation in the number and arrangement of flexed macrochaetae (specimen III); D. Ventral tube; E. Chaetotaxy of the anterior face of ventral tube.

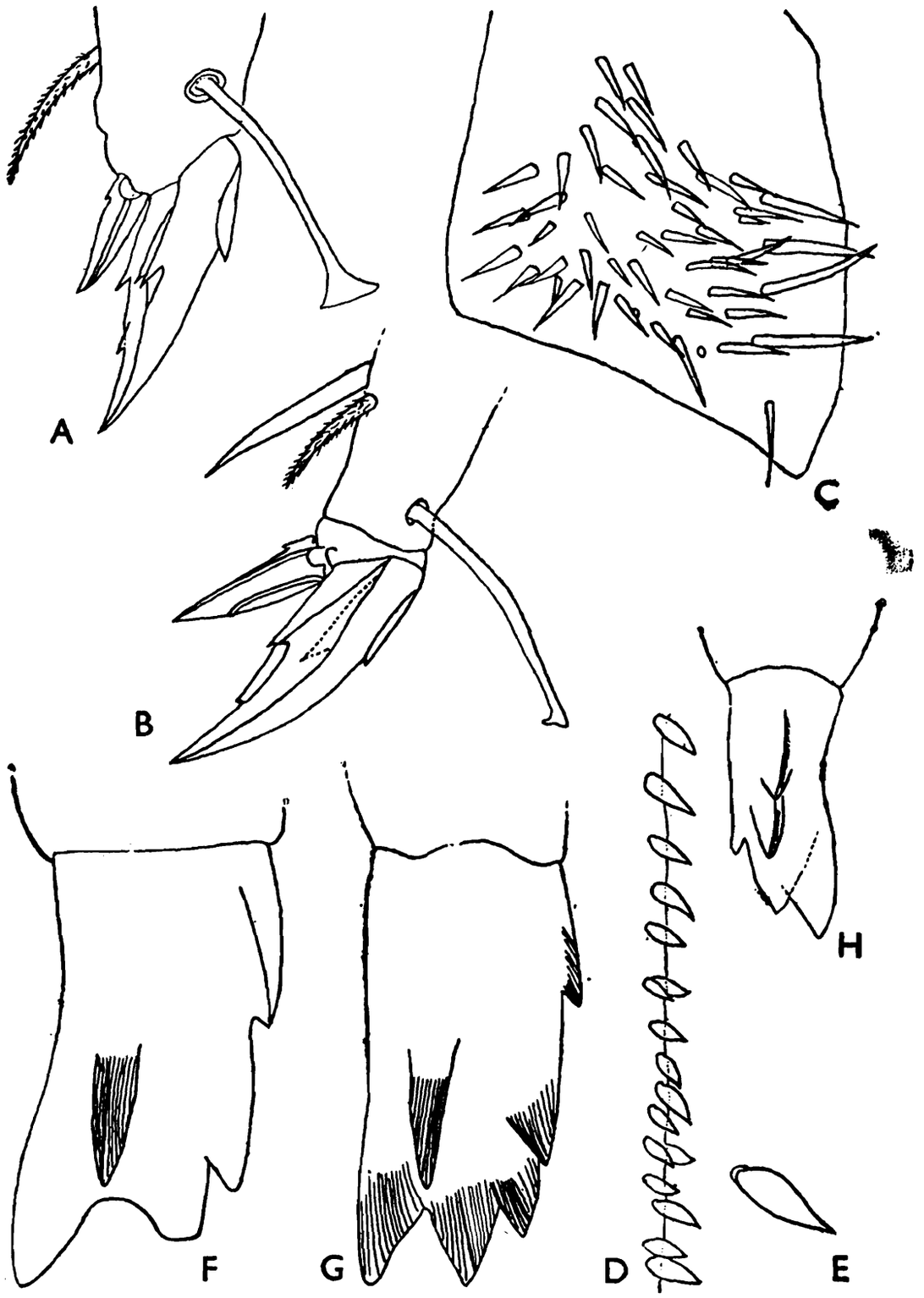
or slightly longer than Ant. II ; characteristic apical sense-knob of Ant. IV present and guarded with some smooth setae (Text-fig. 4, A) ; prelabral setae 4, smooth, labral setae 5, 5, 4, smooth, labral margin with 4 conspicuous tubercles.

Thorax.—Relative length index of Ths. II : III = 46 : 32 ; Imms' (1912) calculation of ratio of Ths. II : III as 12 : 5 somewhat confusing [in the syntype examined (Text-fig. 1, A and plate 1, A), ratio of Ths. II : III = 55 : 36] ; legs all similar ; unguis moderately curved with external basolateral teeth well developed, one on each side near the base of unguis, inner margin of unguis with paired basal and one medial unpaired teeth (in one specimen, 1 very small, second distal tooth observed) ; unguiculus lanceolate acuminate, outer lamella with single tooth (not seen in one specimen) ; tibiotarsal lobes reduced, tenent hairs slender, broadly clavate (Text-fig. 5, A, B) ; trochanteral organ well developed with *c.* 63 spines (Text fig. 5, C) ; each tibiotarsus with 6-7 very stout, stiff, spiniform setae on inner lateral margin.

Abdomen.—Relative length index of Abds. I : II : III : IV : V : VI = 21 : 21 : 13 : 108 : 9 : 4; ventral tube long with 3 protrusible vesicles and 2 small rudimentary vesicles towards anterior face (Text-fig. 4, D) ; anterior face with several macrochaetae transiting posteriorly, general surface of anterior and posterior faces with long slender microchaetae (Text-fig. 4, E) ; rami of retinaculum each with 4 teeth, corpus with a median seta ; furcula stout, relative length index of manubrium : mucrodens=85 : 122 ; each dentes armed with an inner row of spines which transit into stiff ciliated setae distally, spines may be faintly striated, mucro large with 5-6 teeth (Text-fig. 5, D-H)

Length (excluding appendages) : 2-3 mm.

Type-specimens.—Imms (1912) deposited some of the syntypes of *D. fasciculatus* in the British Museum (Nat. Hist.), London. Other syntypes which were deposited in the collection of the Indian Museum, Calcutta, were lost in a flood of the River Varuna at Benaras in 1943 when most of the collections were shifted there. The syntype of the British Museum (Nat. Hist.), which the author had an opportunity to examine, bears label having identical data as regards locality, collector, etc., as mentioned by Imms (1912) ; the investigator, therefore, takes this opportunity to designate it as the lectotype. Details of the lectotype are as follows : Male, body pigmentation as in Text-fig. 1,A and plate 1,A ; Ants. I :II=17 :22 (Ants. III and IV broken) ; Ths.

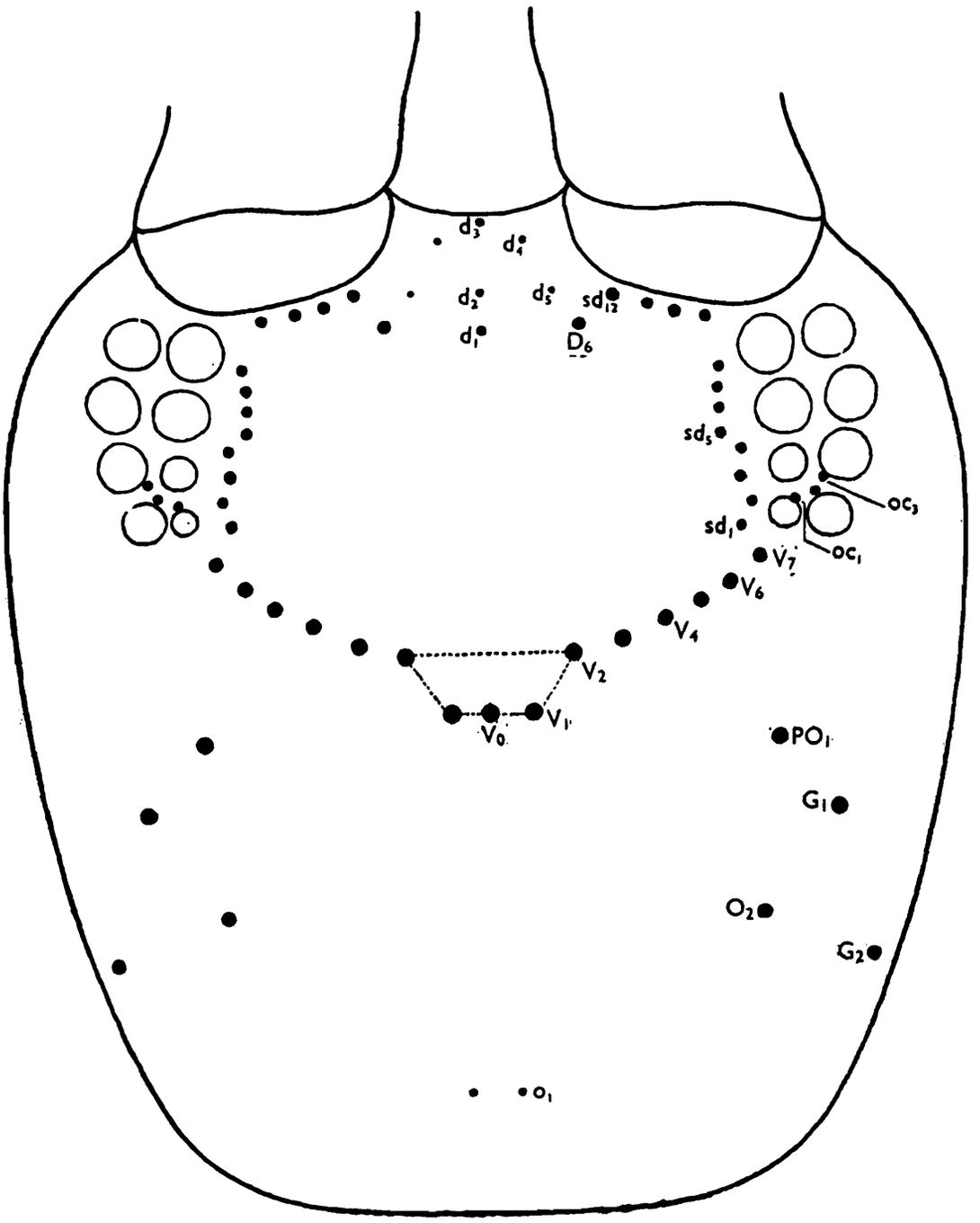


Text-fig. 5. *Dicranocentroides fasciculatus* Imms. A. Foot-complex of leg I (specimen from Lansdowne, U.P.); B. Do, leg III (specimen from Sahasradhara, U.P.); C. Trochanteral organ (specimen from Sahasradhara, U.P.); D. Portion of a dentes showing arrangement of spines (specimen from Sahasradhara, U.P.); E. A dental spine, magnified; F. G. Mucrodens from single specimen (specimen from Sahasradhara, U.P.); H. Do, from a specimen of Lansdowne, Pauri Garhwal, U.P.

II : III=55 : 36 ; Abds. I : II : III : IV : V : VI=24 : 25 : 13 : 142 : 13 : 9; manubrium : mucrodens = 19 : 40 ; total length (excluding appendages) = *c.* 3 mm.

Type-locality—Kumaon, India.

Comparisons.—*Dicranocentroides fasciculatus* Imms (1912) is quite interesting from the point of view of its striking sexual dimorphism in colour pattern and its variation. Description of colour pattern and its illustration, given by Imms (1912), are not very revealing. The syntype examined has darker pigmented patches on thoracic and abdominal segments (Text-fig. 1, A and



Text-fig. 6. *Dicranocentroides fasciculatus* Imms. Cephalic chaetotaxy.

plate 1, A) in contrast to Imms' (1912) illustration which does not exhibit such colour patterning. Colour pattern of *D. fasciculatus* is very similar to *D. plumicornis* (Parona, 1892) and *D. coomani* Delamare Deboutteville (1948) ; examination of the type-material or topotypes of the two latter species can only precise the actual relationship of these three species. Presence of large quadrangular prothorax mentioned and illustrated (p. 12 and Fig. 7) by Delamare Deboutteville (*l. cit.*) in *D. coomani* appears incongruous and it must be mesothorax of the species. *Paronella crassicornis* Carpenter (1917) is evidently a synonym of *D. fasciculatus* with which it fully agrees in colour pattern and other structural details. Carpenter (1917) overlooked the presence of dental spines as well as inner lateral tooth of mucro. Specimens, which were determined by Prof. Salmon (1957) as *D. fasciculatus,* represent a new species owing to their characteristic colour pattern not conforming to any specimen of *D. fasciculatus* examined by the present author. The new species is named as *D. salmoni* and is described in detail below.

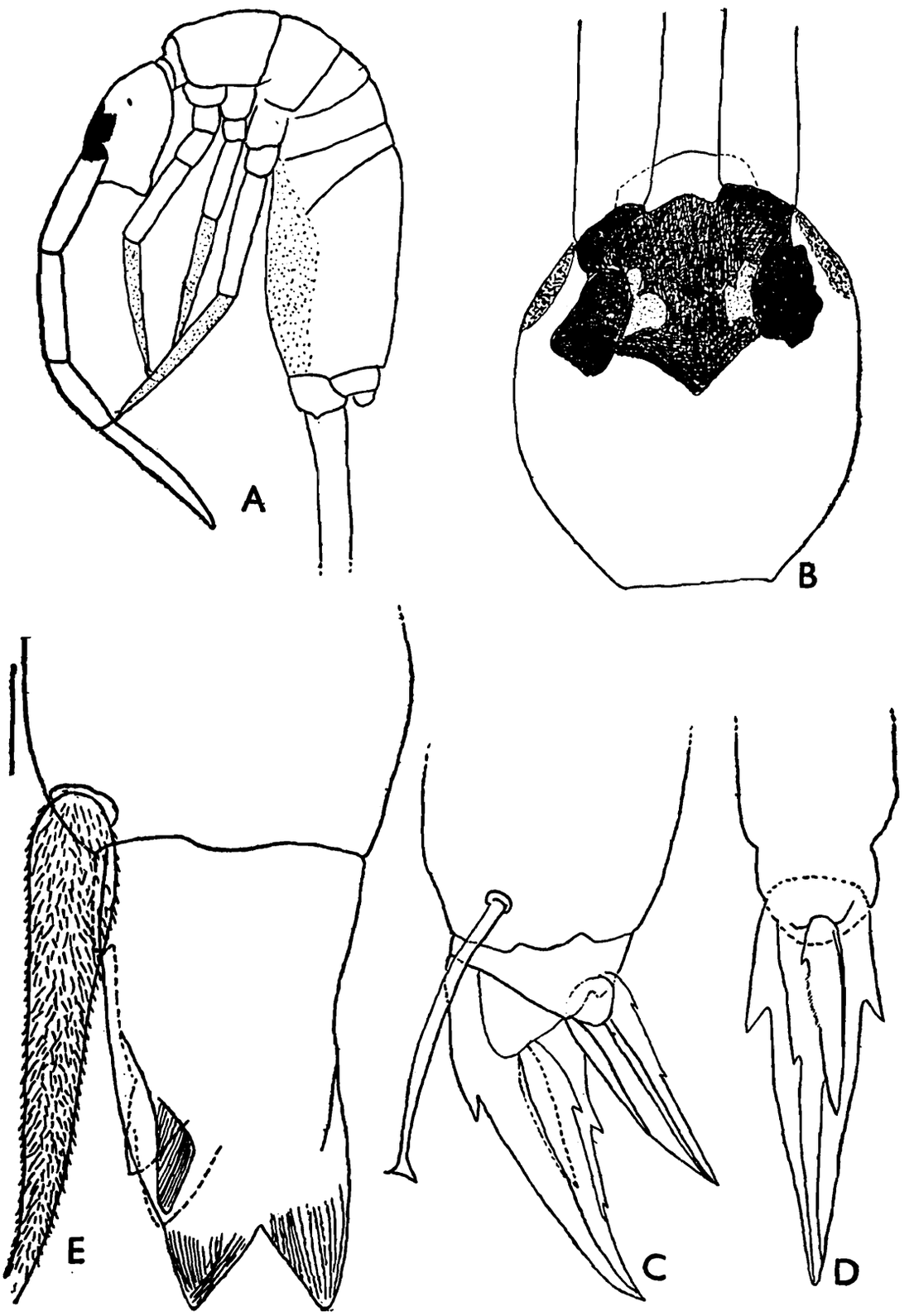
2. **Dicranocentroides flavescens** Yosii

(Text-figs. 7-13)

1966. *Dicranocentroides fasciculatus* f.n. *flavescens* Yosii, *Res. Kyoto Univ. Sci. Exped. Karakoram and Hindukush,* 1955, **8** : 333-405.

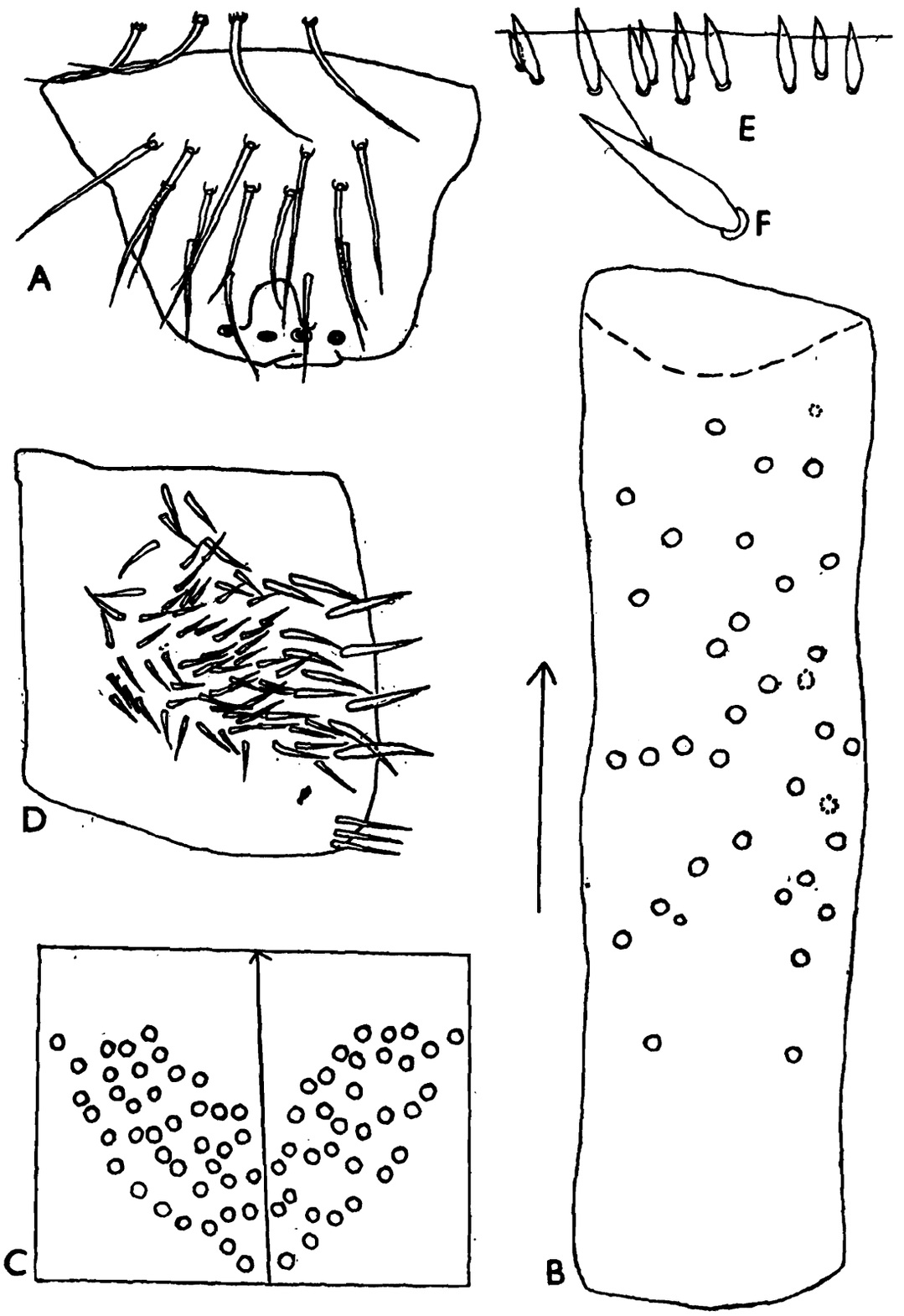
Material.—Uttar Pradesh, India—Saharanpur, Saharanpur district, 2.v.1964, *S. K. Mitra* coll., 25 exs. (creeping on the surface of dried leaves of *Bambusa* under the shade of trees) ; West Bengal, India, Chandannagar, Hooghly district, 12.x.1965, *S. K. Mitra* coll., 3 exs. (creeping on the surface of dried leaves of *Bambusa)* ; Amtala, 24-Parganas district, 12.vi.1966, *S. K. Mitra* coll., 5 exs. ; Botanical gardens, Howrah district, 14.viii.1966, *S. K. Mitra* coll., 10 exs.

Colouration (Text-fig. 7, A).—Ground colour of body pale yellow when denuded of scales, brownish when scales retained ; in general, darker patches absent on body, in some examples, tergal margins and lateral margins of Abd. IV including posterior extensions of Abd. III with faint bluish pigment ; a dark patch, characteristic of the species (Text-fig. 7, B), present on vertex in between two ocellar fields ; antennae not pigmented, base of Ant. I with a dark blue-black patch, Ant. IV darker in some specimens ; tibiotarsi with bluish pigment,



Text-fig. 7. *Dicranocentroides flavescens* Yosii. A. Profile (specimen from Saharanpur, U.P.); B. Head, showing pigmentation; C. Footcomplex of leg III; D. Do, leg II; E. Mucrodens complex.

Clothing.—Scales clothing body with round, acuminate and truncated apices; macrochaetae obliquely truncated, ciliated,



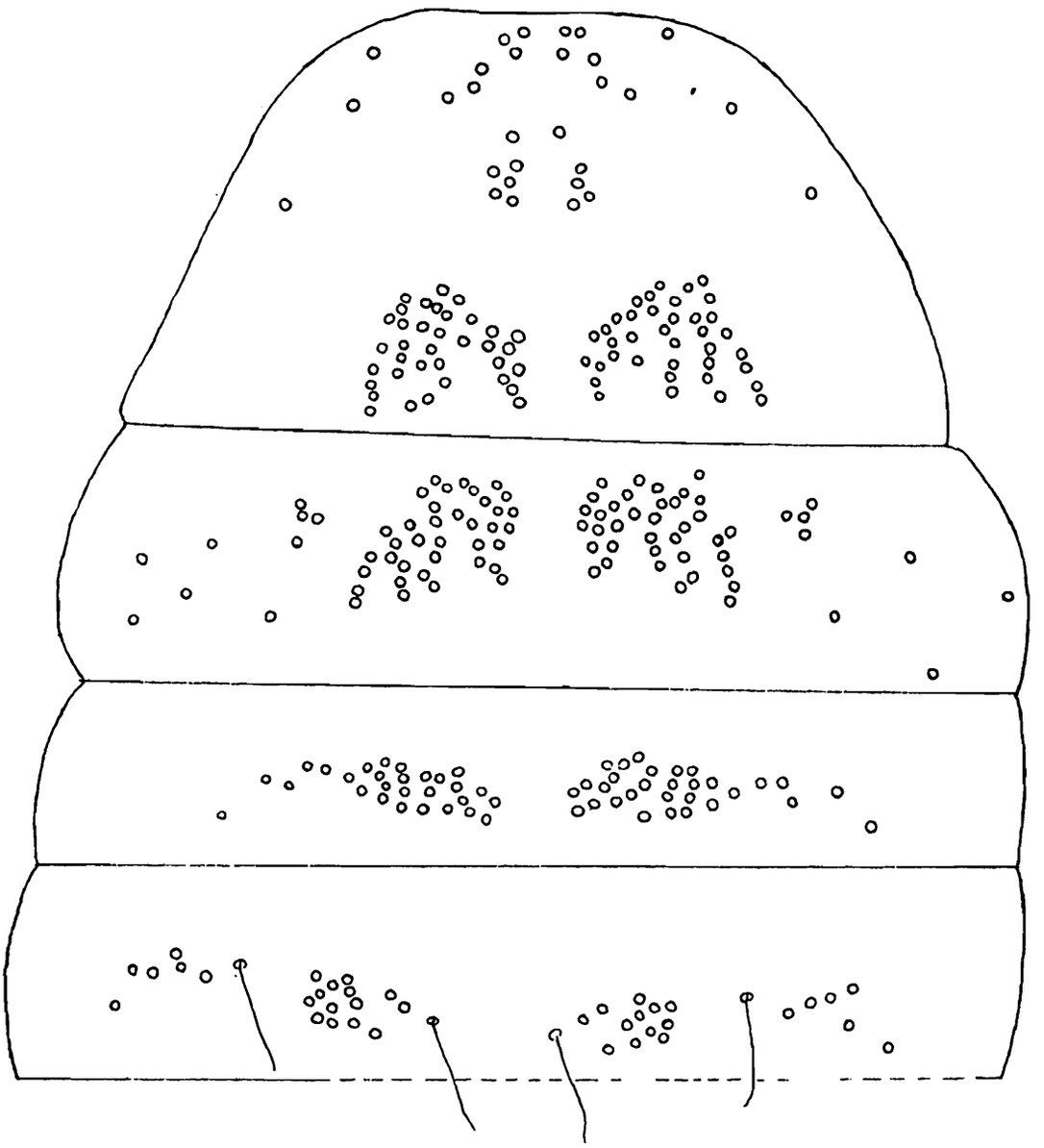
Text-fig. 8. *Dicranocentroides flavescens* Yosii. A. Labral chaetotaxy; B. Chaetotaxy of Ant. I; C. Chaetotaxy of the posterior region of Abd. IV; D. Trochanteral organ; E. Portion of a dentes showing arrangement of spines; F. A dental spine, magnified.

present on head and body segments; number and arrangement of setae on head and body segments variable; chaetotaxy—head

(Text-figs. 11-13) : vertex with V_0+V_{1-7} ; dorsal region with 6 setae, d_{1-3} unpaired, located on middorsal line, D_6, a macrochaeta ; subdorsal region with 14-17 setae, SD_8 may be a macrochaeta ; ocular region with 3 microchaetae (oc_{1-3}) ; postocular and occipital regions each with a single macrochaeta (PO_1, O_1) on each side ; genal region with 2 macrochaetae on either side (G_{1-2}) ; in the specimens from Calcutta, 2-3 variable and asymmetrical macrochaetae noted on vertex (Text-figs. 11, 12) ; in the specimens from Saharanpur, some variable macro- and microchaetae occur in the parietal and occipital regions (Text-fig. 13) ; body (Text-figs. 8-10) : the number of setae on Ths. II, III, Abds. I, II varies from 42-46 (setae located posteriorly on the segment including 5-6 medial setae), 45-49/24-31, 16-20 respectively ; much asymmetry observed in the number and arrangement of setae, for example in I (Text-fig. 9)—Th. II : 46/46 (excluding those on anterior margin), Th. III : 49/49, Abd. I : 24/31 and Abd. II : 16/19 ; in others (II) (Text-fig. 10)—Th. II : 43/43 (including posterior group and 5-6 median setae), Th. III : 46/46, Abd. I : 28/30 and Abd. II : 20/18 ; however, the number and arrangement of 5-6 setae in the middle of Th. II—very characteristic ; range of the number of macrochaetae on Ant. I varies from 30-37 and in no case less than 30 setae occur on this segment (Text-fig. 8, B) ; Abd. IV medially with 21 setae on each side and posteriorly with 40 + 32 setae (Text-fig. 8, C).

Head.—Pear-shaped when viewed from above ; 1 + 1 dark ocellar field, each field containing 8 ocelli arranged in two longitudinal parallel rows, ocelli G and H smaller than the rest ; antennae subequal to body ; relative length index of Ants. I : II : III : IV = 15 : 17 : 12 : 19 ; apical sense organ of Ant. IV normal ; prelabral setae 4 smooth, labral setae 5, 5, 4, smooth, labral margin with 4 rounded tubercles, median intrusion rounded (Text-fig. 8, A).

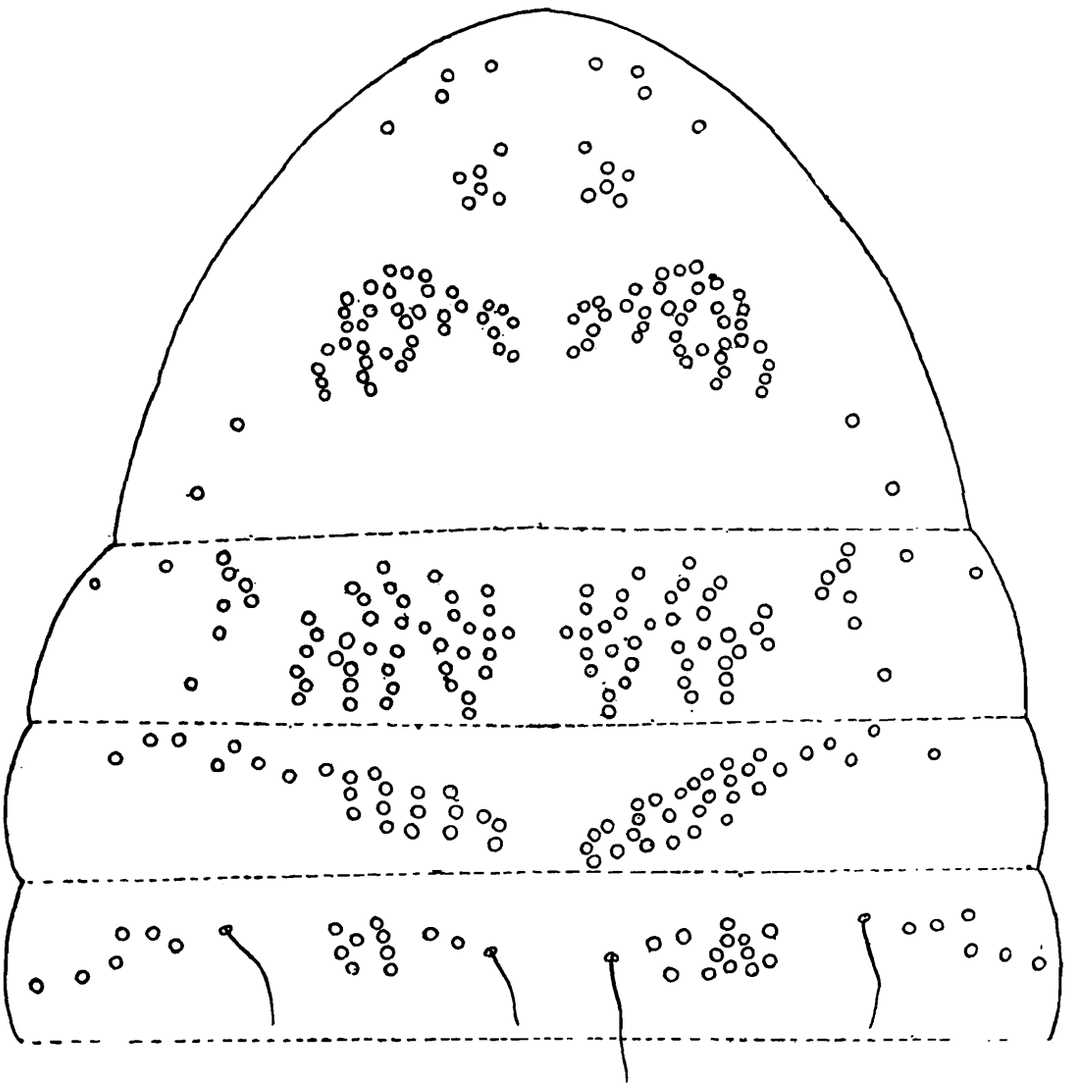
Thorax.—Relative length index of Ths. II : III = 14 : 8.5 ; legs all similar, unguis slightly curved with paired external basolateral teeth, one on each side of unguis, inner margin of unguis with paired inner basal and a median unpaired teeth ; unguiculus lanceolate, acuminate, usually with 2 external teeth, in some examples single external tooth perceptible near base and rest medially somewhat ciliated (Text-fig. 7, C, D) ; tibiotarsal lobes inconspicuous ; tenent hair well developed, clavate ; trochanteral organ with *c.* 77 slender, short spines (Text-fig. 8, D) ; each



Text-fig. 9. *Dicranocentroides flavescens* Yosii. Chaetotaxy of Ths. II, III/Abds. I, II from a specimen of Saharanpur, U. P. (Note : The asymmetry in number and arrangement of setae on Abds. I, II).

tibiotarsus with 6-7 very stout, stiff spine-like setae on inner lateral margin.

Abdomen.—Relative length index of Abds. I : II : III : IV : V : VI = 5 : 6 : 4 : 39 : 5.5 : 2 ; ventral tube long with protrusible vesicles retracted ; anterior face of ventral tube anteriorly with a row of macrochaetae which transit posteriorly, general surface of anterior and posterior faces with slender, long microchaetae ; rami of retinaculum each with 4 teeth, corpus with a median seta ; relative length index of manubrium : mucrodens = 28 : 38 ; dentes armed with two closely apposed rows of spines on inner



Text-fig. 10. *Dicranocentroides flavescens* Yosii. Chaetotaxy of Ths. II. III/Abds. I, II from a specimen of Saharanpur, U.P. (Note : Asymmetry in the number and arrangement of setae).

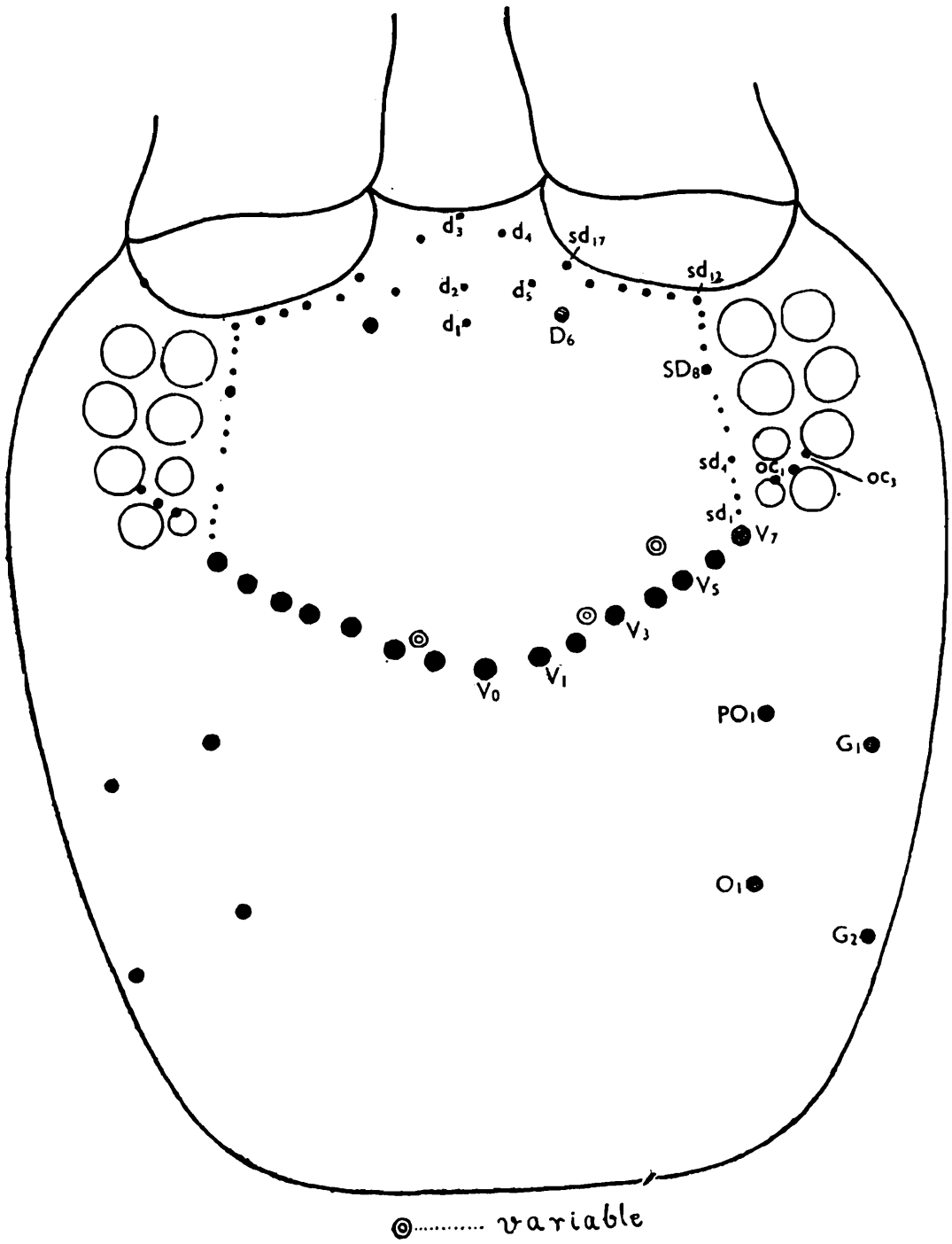
margin (Text-fig. 8, E, F) ; mucro large, parallel sided with 6 teeth (Text-fig. 7, E)

Length (excluding appendages) 2-3.5 mm.

Type-specimens.—Yosii (1966) based the description on 4 specimens and did not select any type for his "f.n. *flavescens*" Therefore, the examples on which he based the description have the status of syntypes. The syntypes are in the collection of Prof. R. Yosii, Yoshida College, Kyoto University, Japan.

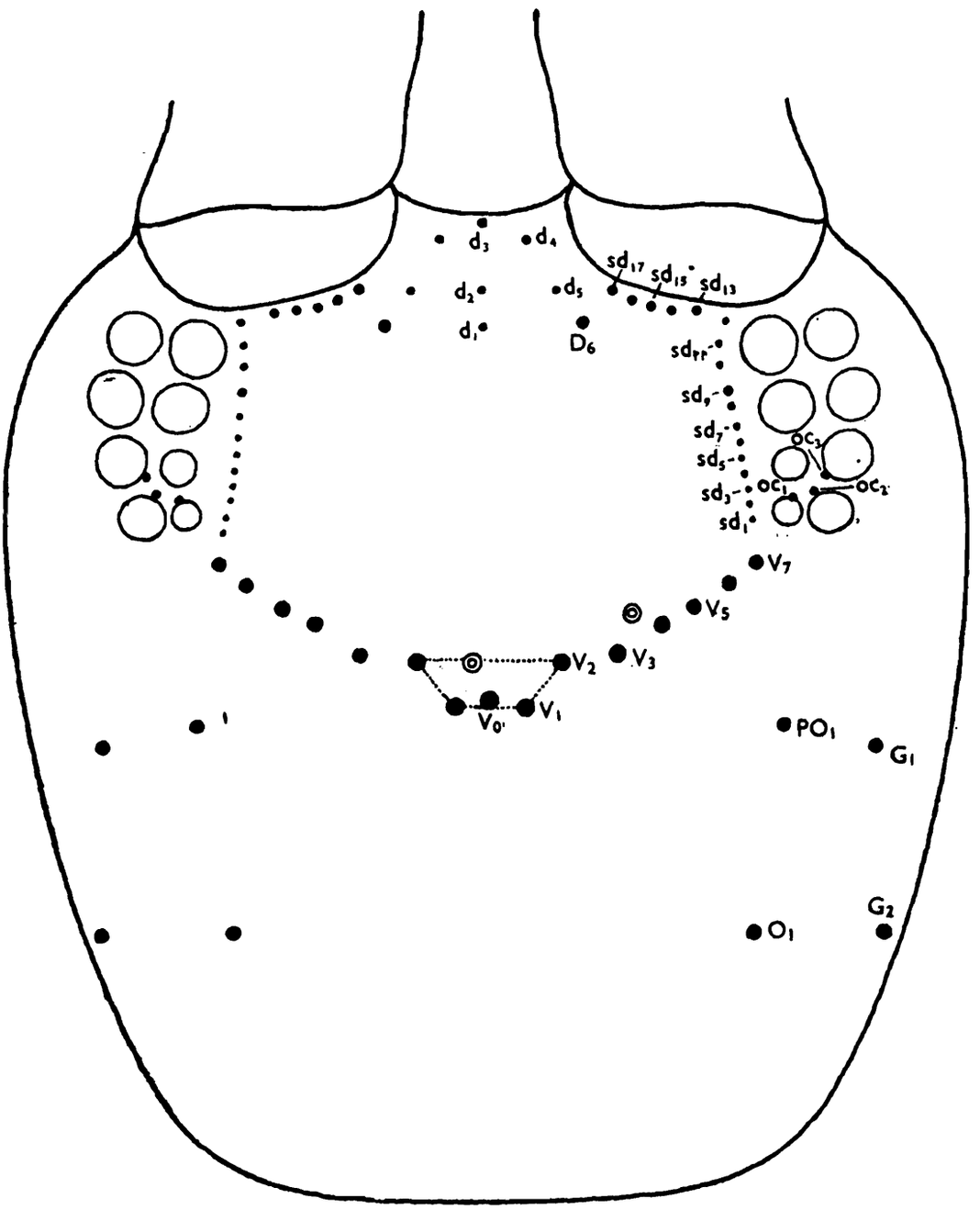
Type-locality.—Yosii (1966) based the description of the species on 4 exs., which came from the Botanical Gardens, Calcutta and Khandala near Bombay. The present investigator takes this opportunity to fix Calcutta Botanical Gardens, Howrah district, West Bengal, India, as the type-locality of the species.

Comparisons.—Yosii (1966) described the species as *Dicra-*



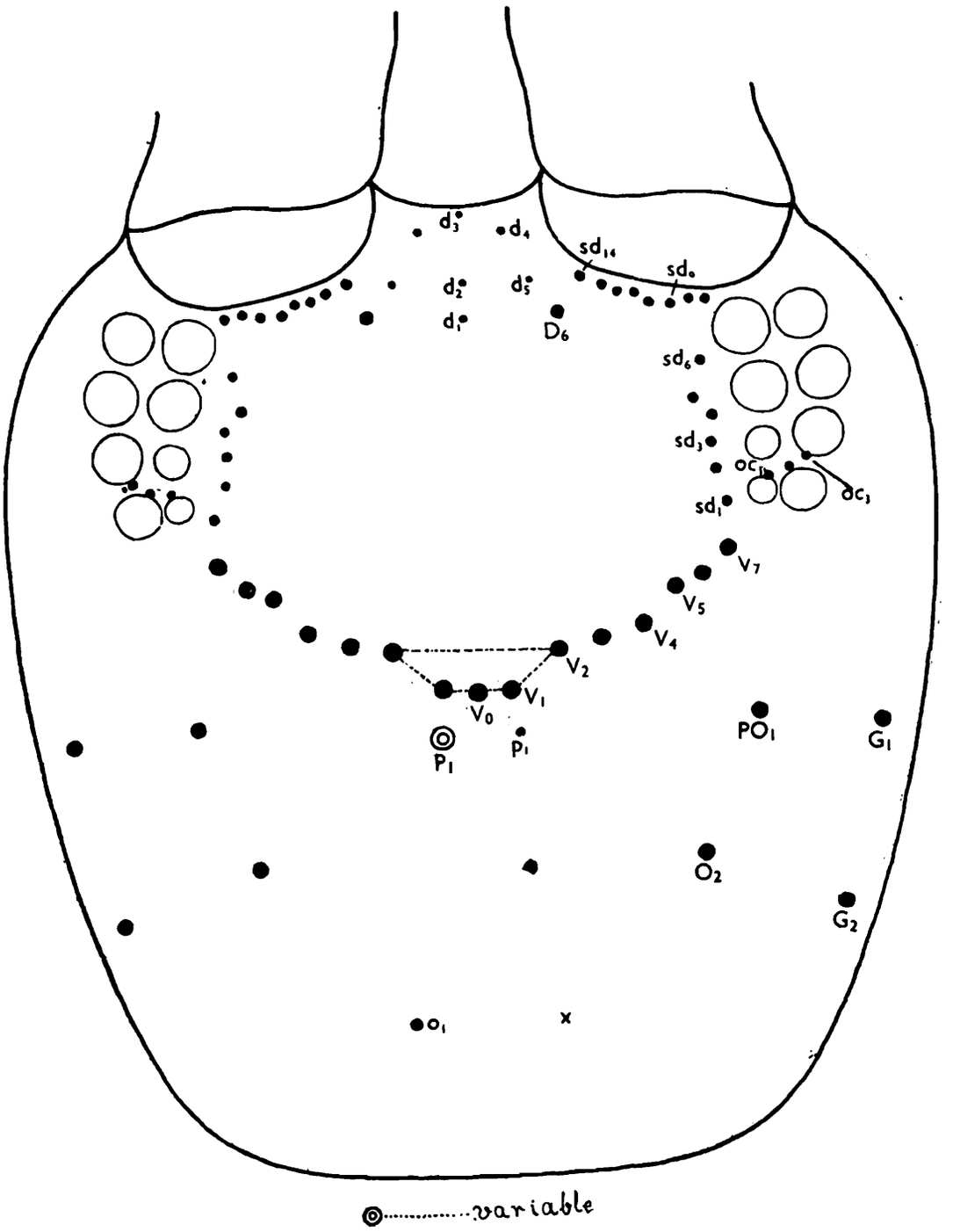
Text-fig. 11. *Dicranocentroides flavescens* Yosii. Cephalic chaetotaxy from a specimen of Calcutta. (Note: The variable setae on vertex and dorsal regions).

nocentroides fasciculatas Imms, 1912 and he considered it as a new form viz., "f.n. *flavescens*" owing to its different colour pattern and also apprehended that this might be an independent species. Now, a detailed examination of many examples of this species from two widely different localities along with the representative collections of *Dicranocentroides fasciculatus* as



Text-fig. 12. *Dicranocentroides flavescens* Yosii. Cephalic chaetotaxy from a specimen of Calcutta. (Note: The variable setae, represented by double bordered sockets).

well as its lectotype (Photomicrograph on Plate 1, A) proves *flavescens* to be an independent species. *D. flavescens* has a uniform pale yellow ground colour devoid of any dark patches in contrast to *D. fasciculatus* which is always with pigmented patches. Moreover, *D. flavescens* possesses more macrochaetae on antennae, head and body than *D. fasciculatus*. Such differences separate *flavescens* f.n. from *fasciculatus*. Yosii (1966) depicted chaetotaxy of body (Fig. 31F, p. 380) indicating the chaetal



Text-fig. 13. *Dicranocentroides flavescens* Yossi, Cephalic chaetotaxy from a specimen of Saharanpur, U.P. (Note : Variable setae, represented by double bordered sockets).

formula of body as 20,25/17,7 ; such less number of setae indicates that Yosii's observation on chaetotaxy was perhaps based on a juvenile specimen. The presence of only 25-30 setae on trochanteral organ as well as the nature of unguiculus (truncate-type) and the nature of male genital papillae go to confirm this contention of the author. Intrapopulation variations in the number and arrangement of macrochaetae on Ths. II, III and

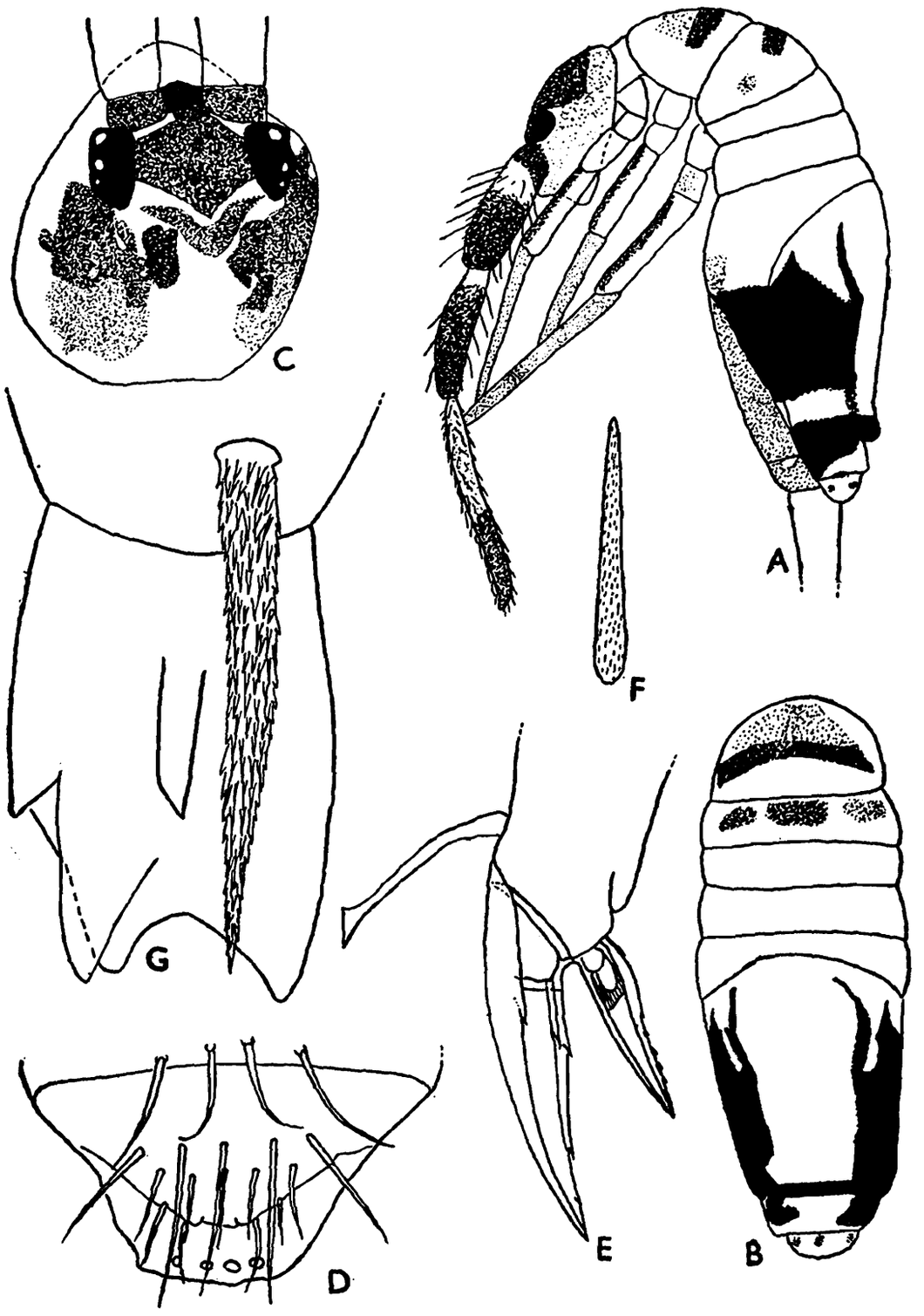
Abds. I, II, III of the population from Saharanpur of the species fairly well coincide with the specimens from West Bengal but the variation in the chaetotaxy of head in the two populations of the species is somewhat aberrant.

3. **Dicranocentroides gisini** n. sp.

(Text-figs. 14-17 and Plate 1, B)

Material.—Uttar Pradesh, India—Tulisot village (between Kalagarh and Dhikala), Kalagarh district, 1.iii.1965, *S. K. Mitra* coll., 15 exs. (creeping on the surface of moist leaves of *Bambusa* in the foothills) ; Dhikala village, Kalagarh Forest Division, Nainital district, 1.iii.1965, *S. K. Mitra* coll., 10 exs. (creeping on the surface of moist leaf litter deposited on rocks).

Colouration.—General ground colour of body pale yellow ; Ths. II, III, Abds. I, II, III usually devoid of any dark pigmented patches ; in some examples, Th. II medially with two patches, each patch proximally lighter and distally darker and disposed, in the form of an interrupted band, these patches sometime tend to coalesce and form a continuous band ; Th. III with three transverse patches of which the median one darkest ; Abd. IV laterally and lateral extensions of Abd. III with two common symmetrical patches of blue-black pigment, one on each side at about half of their length ; besides this, extremity of Abd. IV on each side with a transverse blue-black pach which extends posteriorly on Abd. V, Abds. IV and V medially devoid of darker patches ; transverse patch present posteriorly on Abd. IV sometime tends to be confluent with the medio-lateral patch on the segment, Abd. VI with three dot-like pigmented patches ; pigmentation of head characteristic and as in Text-fig. 14, C ; pigmentation of antennae varies according to the number of segments, thus, in the forms having 3 segmented antennae, Ants. I, II completely dark except a proximal nonpigmented ring-like zone, Ants. III + IV only distally darker ; in 4 segmented forms, Ant. I nonpigmented except a distal blue-black ring, 3/4th of Ant. II distally completely dark, rest nonpigmented, Ant. III little darker distally, Ant. IV totally dark except a small basal nonpigmented zone ; tibiotarsi entirely with violet pigment, the region of its subdivision not pigmented ; femora on inner margin with a dark longitudinal streak ; colour pattern of body

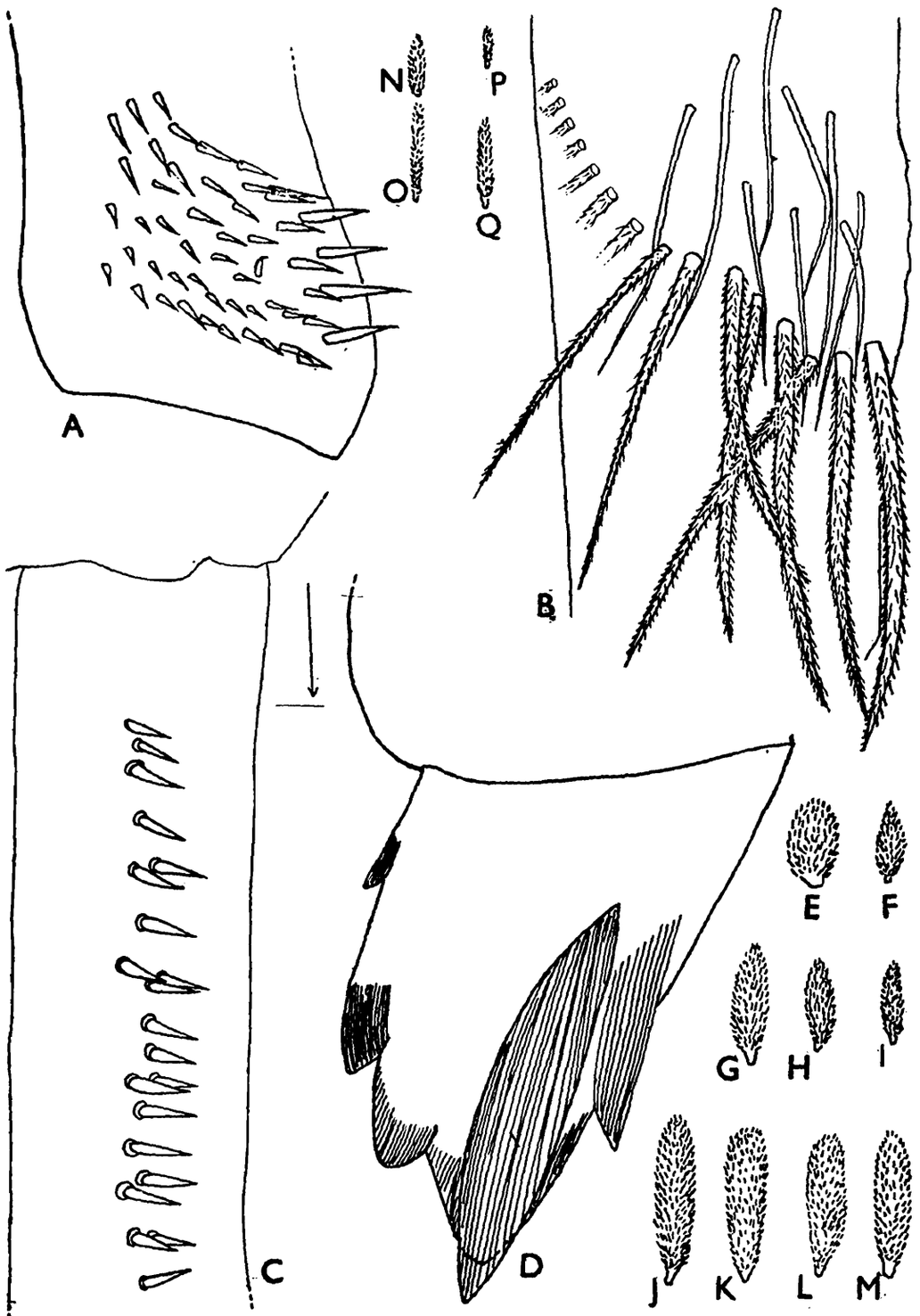


Text-fig. 14. *Dicranocentroides gisini* n.sp. A, B. Profile showing dorsal and lateral pigmentation; C. Head, showing characteristic pigmentation; D. Labral chaetotaxy; E. Footcomplex of leg III; F. Tibiotarsal spine; G. Mucrodens complex.

specially of Abd. IV strikingly constant in all the individuals examined (Text-fig. 14, A, B).

Clothing.—Body clothed with scales and dark, flexed macro-

chaetae (brush setae) ; macrochaetae present on head, Ths. II, III, Abds. I, II ; Abd. IV medially and posteriorly and Abds. V and VI posteriorly with acuminate ciliated macrochaetae ;



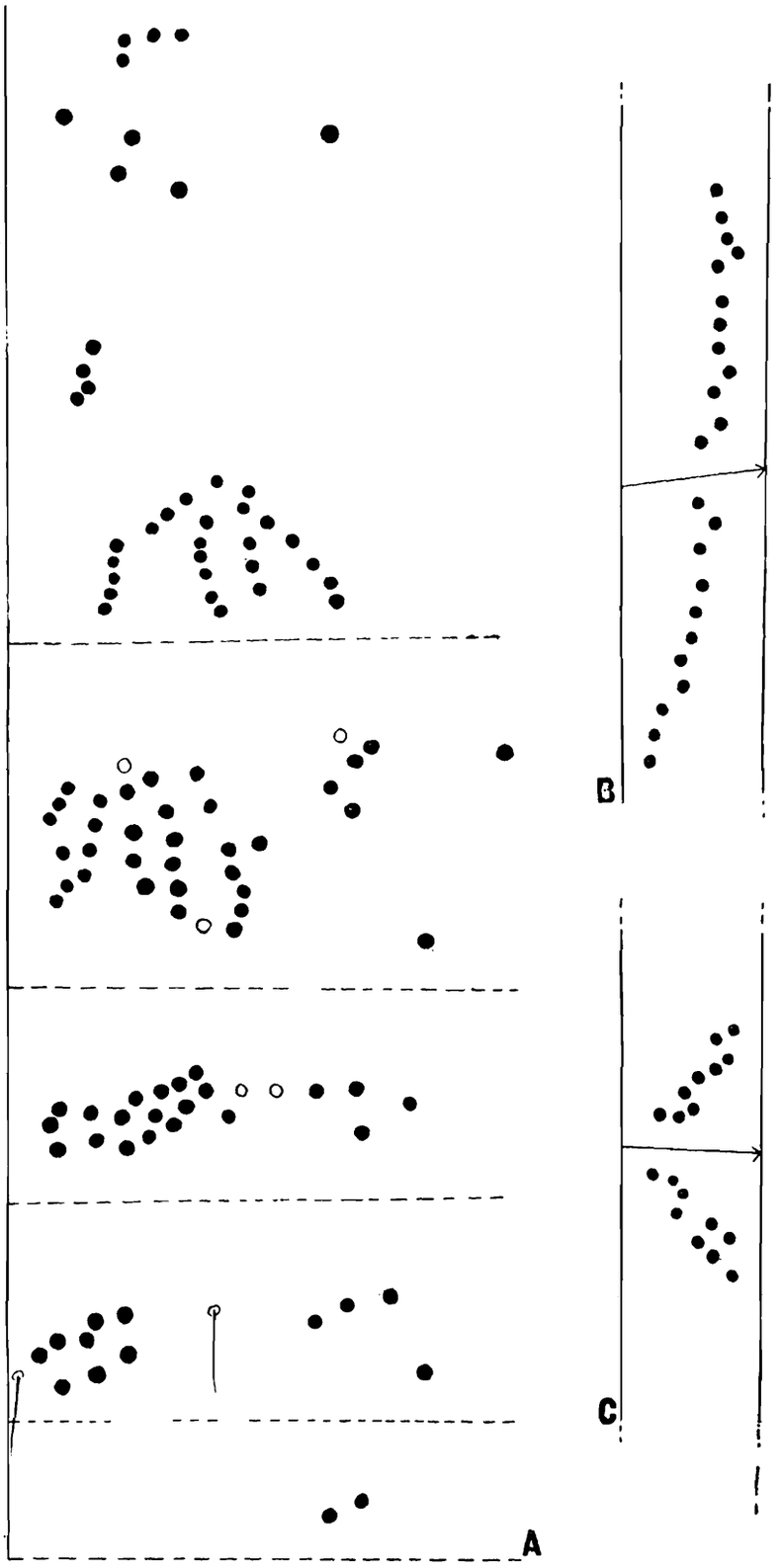
Text-fig. 15. *Dicranocentroides gisini* n.sp. A. Trochanteral organ; B. Chaetotaxy of the anterior face of ventral tube ; C. Portion of dentes showing arrangement of spines ; D. Mucrodens complex ; E-Q. Scale-primordia and pseudoscales from Abd. IV.

chaetotaxy—head (Text-fig. 17) : vertex with V_0 + V_{1-7} ; dorsal region with 6 setae, d_{1-3} unpaired ones, located on middorsal line and D_6, a macrochaeta ; subdorsal region with 11 setae, SD_5 and SD_{7-11} macrochaetae ; ocular region with 3 microchaetae (oc_{1-3}) ; post-ocular region represented by single macrochaeta (PO_1) ; occipital region with single, variable microchaeta (o) and a macrochaeta (O_2) ; genal region on either side represented by 2 macrochaetae (G_{1-2});area cervicalis with single, variable microchaeta on each side (C_1) ; body (Text-fig. 16, A-C) : macrochaetal formula of Ths. II, III/Abds. I, II, III = 25 (including posterior group and 4 medial setae, number of arrangement of median setae fairly constant), 35-37/21-23, 12, Abd. III medially with 2 macrochaetae (Text-fig. 16, A) ; Abd. IV medially with a transverse row of 12 + 11 setae and posteriorly with 9 + 9 setae (Text-fig. 16, B, C) ; body scales with rounded and acuminate apices, certain scales located in the middorsal regions of Th. III, Abds. I, II with truncated apices ; besides, many transitional scale-primordia found on the general surface of body (Text-fig. 15, E-Q).

Head.—Pear-shaped when viewed from above ; 1 + 1 dark ocellar field, each field containing 8 ocelli arranged in two longitudinal parallel rows, ocelli G and H smaller than remainder ones ; antennae subequal to the length of head and body ; much anomaly observed in the number of antennal segments which varies from 3-4 segments, relative length index of antennae with 3 segments = 17 : 19 : 35, with 4 segments = 11 : 15 : 16 : 20 ; apical sense organ of Ant. IV normal ; prelabral setae 4, smooth, labral setae 5, 5, 4, anterior margin of labrum with 4 round tubercles (Text-fig. 14, D).

Thorax.—Relative length index of Ths. II : III = 14 : 9.8 ; legs all similar, unguis little curved with 2 external basolateral teeth, one on each side of unguis, inner margin of unguis with paired inner basal, a medial and a distal unpaired teeth ; unguiculus lanceolate, acuminate, usually with 5 teeth on outer lamella in the form of serrations ; inner tibiotarsal lobe conspicuous ; tenent hair well developed, clavate (Text-fig. 14, E) ; trochanteral organ with *c.* 53 short, stout spines (Text-fig. 15, A) ; each tibiotarsus with 6-7 very stout, faintly striated spine-like setae on inner lateral margin.

Abdomen.—Relative length index of Abds. I : II : III : IV : V : VI = 7 : 7 : 3.5 : 34 : 5 : 3.5; ventral tube long with protrusible

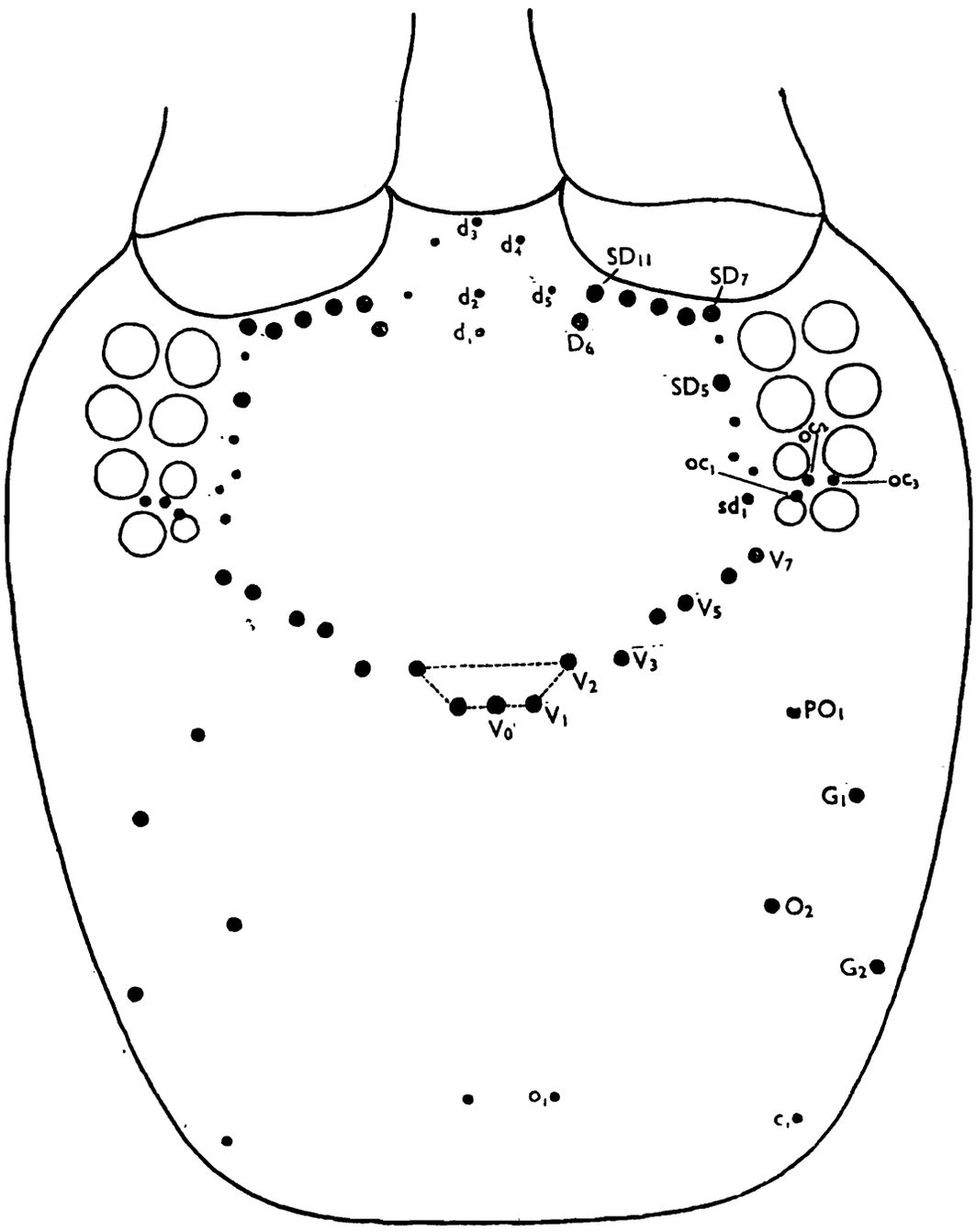


Text-fig. 16. *Dicranocentroides gisini* n. sp. A. Chaetotaxy of Ths. II, III/Abds. I, II, III; B. Arrangement of the median transverse row of setae on Abd. IV; C. Chaetotaxy of the posterior region of Abd. IV

vesicles retracted, anterior face anteriorly with several macrochaetae which transit posteriorly in the form of long, slender

setae (Text-fig. 15, B), general surface of anterior and posterior faces with slender, long, acuminate microchaetae ; rami of retinaculum each with 4 teeth, corpus with a median seta ; relative length index of manubrium ; mucrodens = 27 : 40 ; dentes armed with two closely apposed rows of spines on inner margin, transiting into stiff, ciliated setae from three-fourth of its length distally (Text-fig. 14, C ; Photomicrograph on Plate 1, B) ; mucro large with 6 teeth, lateral tooth large, surpassing beyond the apical tooth (Text-fig. 14, G ; Text-fig. 15, D).

Length (excluding appendages).—2-3 mm.



Text-fig. 17. *Dicranocentroides gisini* n. sp. Cephalic chaetotaxy.

Type-specimens.—Holotype mounted on a slide ; 13 paratypes preserved in spirit ; preserved in the National Zoological Collections, Zoological Survey of India, Calcutta.

Type-locality.—Tulisot village (between) kalagarh and Dhikala), Kalagarh district, Uttar Pradesh, India.

Comparisons.—The species is distinct in its colour pattern from the other known species in the total absence of blue-black pigment on Abds. I, II and medially on Abds. III, IV, V The colour pattern of Abds. III, IV, V and VI is unique and without any variation. Moreover, all the examples examined possess a third distal unpaired tooth on inner margin of unguis which is generally absent in the species mentioned earlier. Chaetotaxically, the new species possesses less number of macrochaetae on body in comparison to *D. fasciculatus* and *D. flavescens.*

The new species is named in honour of Late Dr. Hermann Gisin, Geneva Natural History Museum, Geneva, Switzerland, who left outstanding contributions to the knowledge of Collembolan taxonomy.

4. **Dicranocentroides salmoni** n. sp.

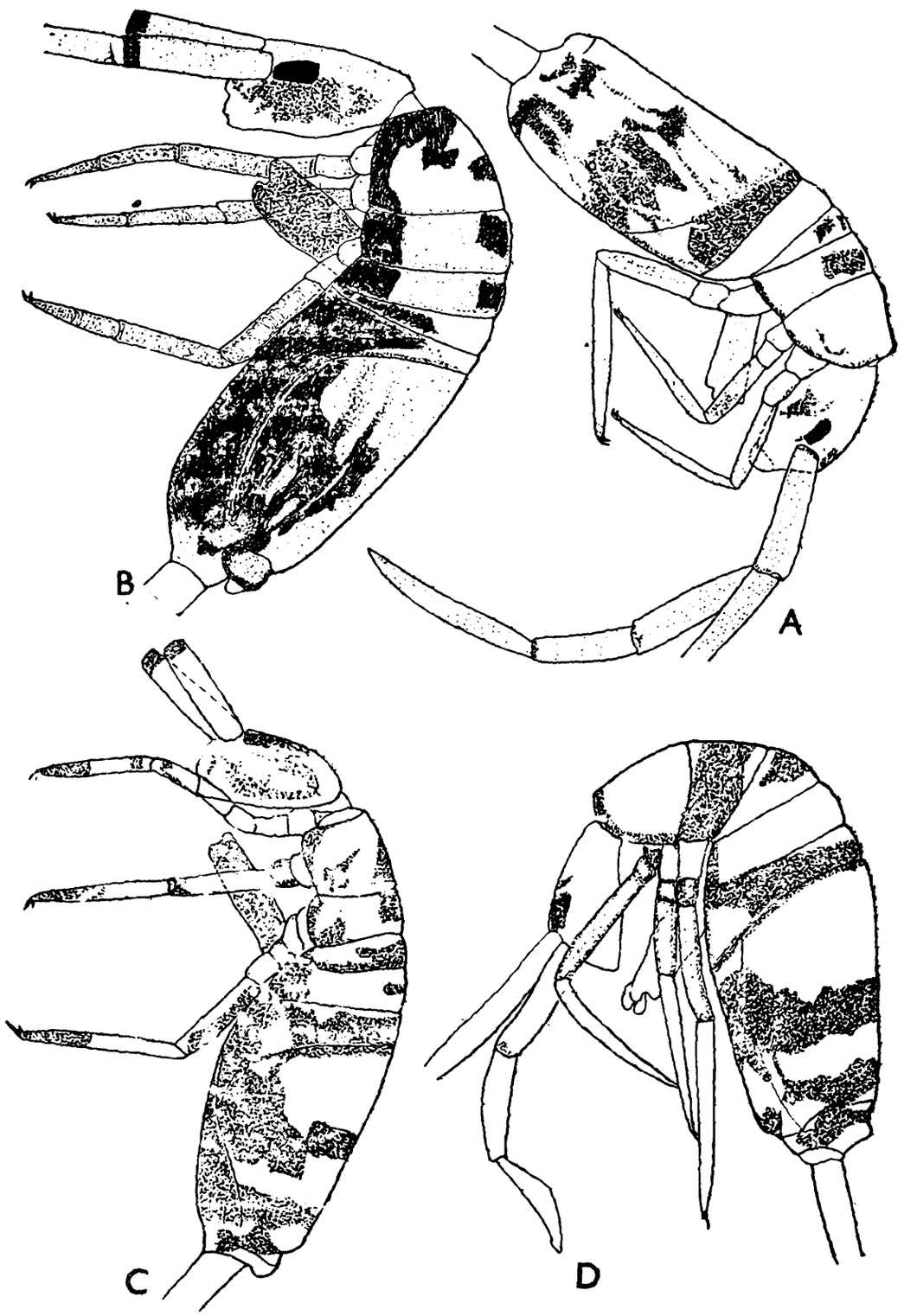
(Text-figs. 18, 19 and Plate 1, C, D)

1957. *Dicranocentroides fasciculatus*: Salmon, *Acta Zool. Cracov.*, **11** (14) : 313-362.

1957. *Handschinphysa crassicornis* sensu Salmon, *ibid.*

Material.—Assam, India—Shillong, 20.v.1965, *B. K. Tikader* coll., 2 exs. ; Sikkim, India—Gangtok (6000 ft.), 11.ii.1952, *T Clay* coll., 1 ex. (Dry and rotting leaves) ; Manipur State, India —Kangpoki (3500 ft.), 23.i.1952, *T Clay* coll., 1 ex. (under stones and leaves ; river's edge) ; Evergreen Forest, Kangpoki (4500 ft.), 24.i.1952, *T Clay* coll., 1 ex. ; Bhutan 13 km. east of Phuntsholing, 19.i.1969, *S. K. Mitra* coll., 10 exs. ; Ganglakha, 31 km. N. E. of Phuntsholing, 24.i.1969, *S. K. Mitra* coll., 10 exs.

Colouration.—A fairly large species with an extremely variable colour pattern (Text-figs. 18, A-D ; 19, A, B ; Pl. 1, C, D) ; male and female of equal magnitude and pigmented with same intensity ; no striking sexual dimorphism in colour pattern exists like *D. fasciculatus* Imms ; Th. III, Abds. I, II almost always dark pigmented ; Th. II sometime without dorsomedian patches, but anterior margin of the segment always pigmented ; Abd. III and its lateral extensions always pigmented, such pigment



Text-fig. 18. Profiles of *Dicranocentroides salmoni* n. sp. A, C. Paratypes [in the British Museum (Nat. Hist.), London] from Manipur State, India ; B. Paratype [in the British Museum (Nat. Hist.), London] from Gangtok, Sikkim ; D. Holotype (in the National Zoological Collections of Z.S.I., Calcutta) from Shillong, Assam.

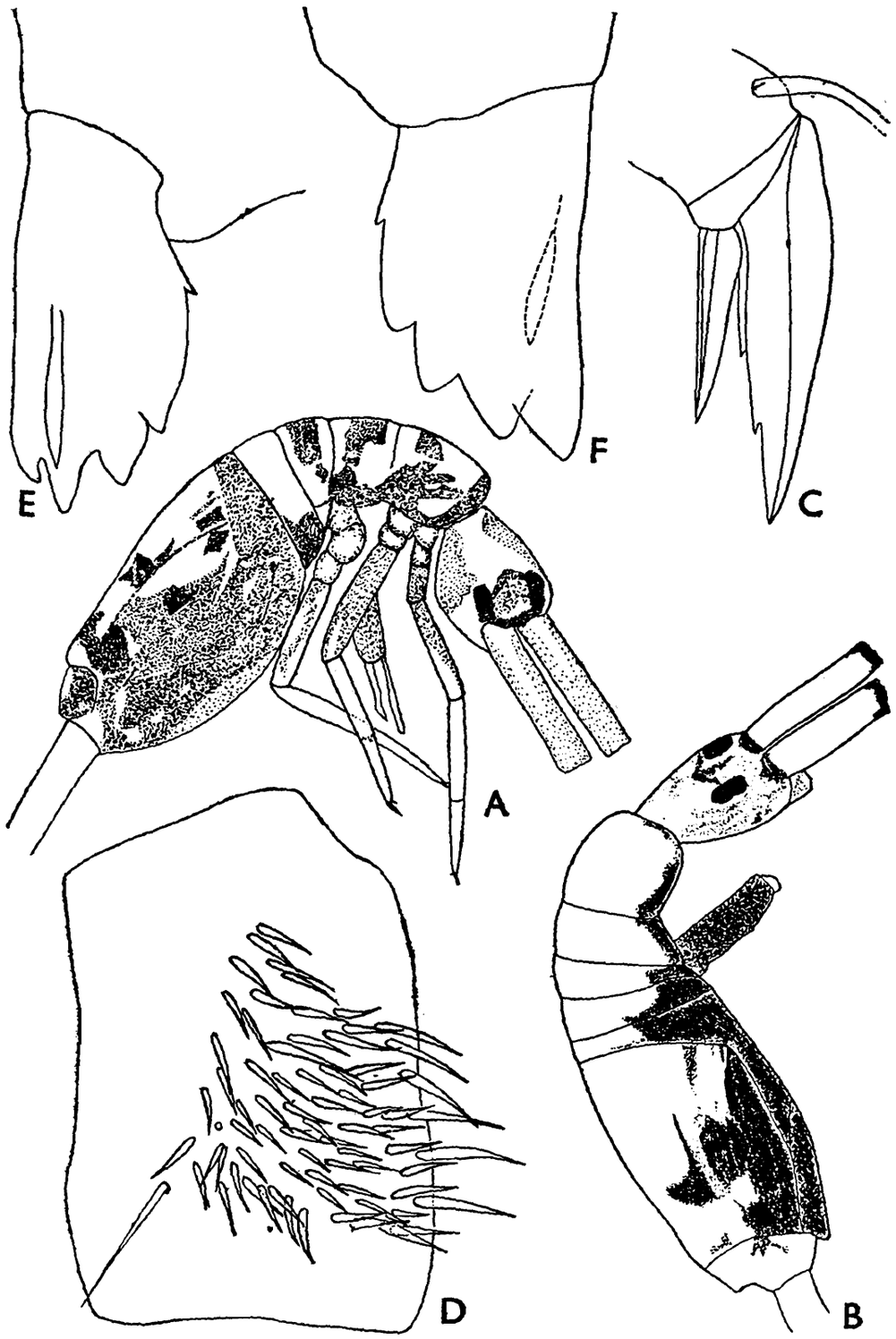
medially and posteriorly forms two transverse bandson Abd. IV or tend to do so, rest of the segment, exceuting the transverse bands, pale yellow and without darker patches in both sexes.

Clothing.—Body clothed with scales and ciliated, obliquely truncated macrochaetae (brush setae) ; brush setae present on head, Ths. II, III and Abds. I, II ; Abd. IV medially and posteriorly and Abds. V, VI posteriorly with acuminate, ciliated setae ; macrochaetal formula of body being 31 (excluding median and anterior setae), 53/31, 14-15 ; Abd. III medially with 2 macrochaetae on each side ; Abd. IV medially with 16 macrochaetae on either side ; most of the specimens denuded of fully developed scales, Abd. IV primarily with scale-primordia of different stages ; fully developed scales mostly elongate with round and sharp apices.

Head.—Pear-shaped when viewed from above ; 1 + 1 dark ocellar field, each containing 8 ocelli arranged in two longitudinal parallel rows, ocelli G and H smaller than the rest ; antennae subequal to the length of head and body ; antennae exhibit much anomaly in segmentation, relative length index of antennae with 4 segments = 20 : 19.5 : 14 : 25, with 3 segments = 22 : 19 : 25 ; Ant. IV apically with a sense-knob guarded with 3-4 smooth setae ; prelabral setae 4, smooth, labral setae 5, 5, 4, smooth, anterior margin of labrum with 4 round tubercles.

Thorax.—Relative length index of Ths. II : III = 14 : 10 ; legs all similar ; tibiotarsi anteriorly superficially segmented ; unguis elongate, slightly curved with paired external basolateral teeth, one on each side and paired inner teeth at middle or so followed by a single, distal, unpaired subapical tooth ; unguiculus lanceolate, acuminate with one tooth on outer lamella ; tibiotarsal lobes poorly developed ; tenent hair long, clavate (Text-fig. 19, C); trochanteral organ with c. 74 stout spines (Text-fig. 19, D) ; each tibiotarsus with 6-7 spine-like setae on inner lateral margin.

Abdomen.—Relative length index of Abds. I : II : III : IV : V : VI = 7 : 7 : 4 : 37 : 4 : 2 ; ventral tube long, protrusible vesicles sometime everted ; anterior face of ventral tube anteriorly with many transiting macrochaetae, general surface of anterior and posterior faces with slender, long, acuminate microchaetae ; rami of retinaculum each with 4 teeth, corpus with a median seta ; relative length index of manubrium : mucrodens = 28 : 40 ; each dentes armed with a row of stout spines that beyond three-fourth



Text-fig. 19. *Dicranocentroides salmoni* n. sp. A, B. Paratypes [in the British Museum (Nat. Hist.), London] showing pattern variations; C. Footcomplex of leg III; D. Trochanteral organ; E, F. Mucrodens complex.

of its length transit into stiff, ciliated setae; mucro large with six prominent teeth (Text-fig. 19, E, F).

Length (excluding appendages).—2-3 mm.

Type-specimens.—Holotype mounted on a slide, preserved in the National Zoological Collections, Zoological Survey of India, Calcutta ; 20 paratypes—5 reposited in the collection of the British Museum (Natural History), London and 15 in the National Zoological Collections, Zoological Survey of India, Calcutta.

Type-locality.—Shillong, Assam, India.

Comparisons.—Salmon (1957) published the description of the specimens from Manipur State as *Dicranocentroides fasciculatus* Imms 1912, and the single specimen (Plate 1, C) from Sikkim, Gangtok as *Handschinphysa crassicornis* (Carpenter). The author examined this single specimen from Sikkim, mounted on a slide, which is labelled as *Paronella crassicornis* Carpenter. After examining the examples from Manipur State, Shillong, Bhutan as well as the above example from Sikkim, Gangtok, the investigator is convinced that all of them are congeneric and conspecific. As it is observed, the single example from Sikkim has, debarring a few, most of its dental spines broken from the base. The new species is quite distinct in its colour pattern from *Dicranocentroides fasciculatus* Imms, which exhibits striking colour dimorphism. The males of *D. fasciculatus* has whole of Abd. IV dark purple and is without distinct medial transverse bands that occur on Abd. IV with nonpigmented zones above and below in the present species. Moreover, the males and females of *D. salmoni* are similar in size and colour pattern.

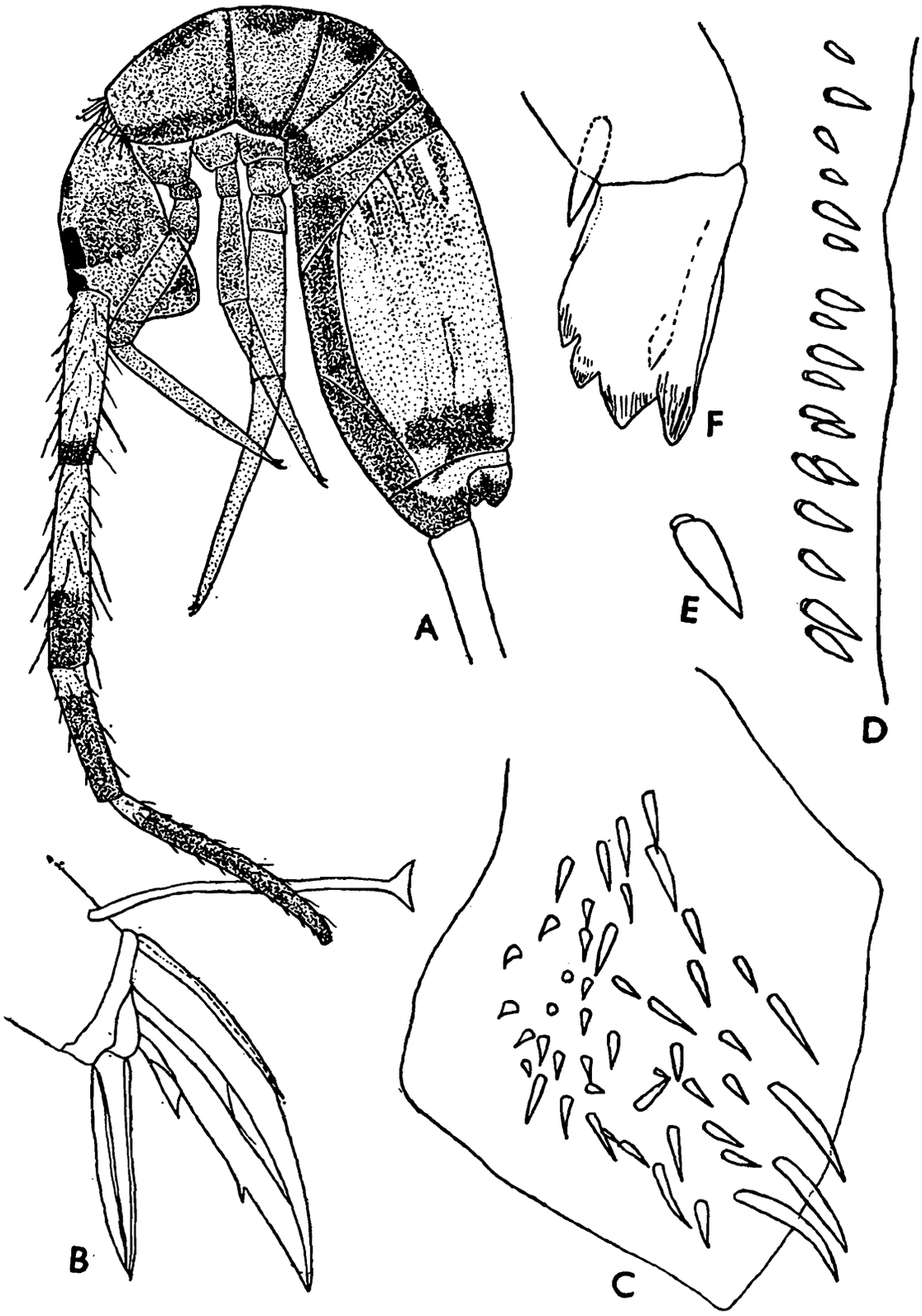
5. **Dicranocentroides indica** (Handschin, 1929) n. comb.

(Text-fig. 20)

1929. *Aphysa indica* Handschin, *Rev. Suisse Zool.*, **36** : 221-262.

Material.—Assam, India—Shillong, 3.v.1965, *B. K. Tikader* coll., 1 ex.

Colouration.—Ground colour brown with faint purple blue pigment all over the head and body ; pigment dark on lateral regions of all tergites and at bases of the flexed macrochaetae and posteriorly on Abds. IV and VI ; faint longitudinal strands descend from the anterior margin of Abd. IV and unite posteriorly ; darker pigment present at bases of antennae and on genae ; Ants. I, II and III each distally with a distinct bluish ring, blue pigment covers three-fourth of Ant. III distally, Ant. IV on most of its part with blue pigment and basally with a narrow non-



Text-fig. 20. *Dicranocentroides indica* (Handschin) n. comb. A. Profile showing pigmentation ; B. Footcomplex of leg III ; C. Trochanteral organ ; D. Portion of a dentes showing spines ; E. A dental spine, magnified ; F. Mucrodens complex.

pigmented zone ; all legs with dark brown pigment ; furca with diffused blue pigment (Text-fig. 20, A).

Clothing.—Body clothed with scales, as characteristic of the

genus ; cervix and anterior margin of Th. II with a "collar" of acuminate setae ; obliquely truncated macrochaetae present on Ths. II, III, Abds. I, II, III ; Abds. IV, V, VI medially and posteriorly with acuminate setae ; Ants. I, II with stiff, dark outstanding macrochaetae as usual of the genus, Ants. III, IV with acuminate, straight and curved setae, in addition, certain apparently non-ciliated, erect setae present on all segments among other setae ; legs and dentes clothed with ciliated, acuminate setae of various sizes, inner lateral margin of each tibiotarsus with a row of 5-6 spine-like setae.

Head.—With two dark ocellar fields, each field containing 8 ocelli arranged in two longitudinal parallel rows, ocelli G and H smaller than others, Ants. I and II stouter than other segments ; relative length index of Ants. I : II : III : IV = 17 : 19 : 13 : 25 ; Ant. IV superficially annulated, apical sense-knob not distinct.

Thorax.—Relative length index of Ths. II : III = 12 : 9 ; legs all similar ; unguis with paired basal and medial unpaired teeth, external basolateral teeth present ; unguiculus lanceolate, without 'tooth-like' serrations on outer lamella ; tibiotarsal lobes not prominent ; tenent hair long, narrow, clavate (Text-fig. 20, B) ; trochanteral organ with *c.* 48 spines (Text-fig. 20, C).

Abdomen.—Relative length index of Abds. I : II : III : IV : V : VI= 6:6:3:29:3:1 ; ventral tube long with protrusible vesicles retracted ; rami of retinaculum each with 4 teeth, corpus with a median seta ; relative length index of manubrium:mucrodens= 22:35 ; each dentes with two closely apposed rows of spines on inner margin which transit distally into stiff setae (Text-fig. 20, D,E,) ; mucro short, almost quadrangular in outline, with six teeth, teeth with striations, v_3 small (Text-fig. 20, F).

Type-specimens.—Handschin (1929) based the description of the species on 3 exs., i.e. syntypes (as he did not select any type) The investigator enquired with the Institution where Prof. Handschin worked (Basel University) and also with the Natural History Museum, Basel and Geneva Natural History Museum, Geneva, Switzerland, in order to trace the existence of the syntypes of the species. Unfortunately, no syntype of the species could be traced in the above-mentioned Institutions and as informed by the authorities, it is most likely, the syntypes are lost.

Type-locality.—Conoor, South India.

Comparisons.—Handschin (1929) although described the

species as *Aphysa indica,* however, the descriptions and depictions of mucrones, footcomplex and profile diagram of the species, given by him, indicate it to be a good member of the genus *Dicranocentroides.* The specimen examined here confirms this view. This species is unique in colour pattern in the presence of purple blue pigment all over the body. The presence of dental spines, absence of frontal spines, nature of antennae and mucrones justify its inclusion in the genus *Dicranocentroides.* Handschin's (1929) profile figure does not represent the actual colour pattern of the species and his illustration on colour pattern is in contradiction with the description. However, the colour pattern of the specimen at disposal fully agrees with Handschin's (1929) description of the species. *D. indica* is close to *D. flavescens* Yosii but differs from it in the presence of faint purple blue pigment all over the body and in its well-pigmented antennae.

Paronella travancorica Imms (1912), described from Madathora (Kerala), possesses (as mentioned and depicted by Imms, 1912) large, quadrangular mucrone, a characteristic feature of the genus *Dicranocentroides.* Further, in the profile diagram of the species, he (Imms) depicted Ants. I, II relatively robust and with outstanding macrochaetae. Prabhoo (1971) although noted dental spines in the examples from several localities of Kerala, yet he treated the species *(P. travancorica)* under *Aphysa,* a genus without dental spines and a junior synonym of *Callyntrura,* instead of *Dicranocentroides.* Further, the nature of foot-complex of the species also suggests its closeness to the species of *Dicranocentroides.* It appears from the present study that *P. travancorica* is a good member of *Dicranocentroides* and future investigation may prove *D. indica* (Handschin) as a synonym of *D. travancorica* (Imms). It is to be noted that the syntypes, deposited by Imms (1912), in the collections of the Indian Museum, Calcutta, were washed away by a flood of the River Varuna at Benaras when the collections were shifted there during World War—II.

Key to Indian species of **Dicranocentroides** Imms

1 Body in general devoid of dark pigmented patches ... 2

Body with distinct dark pigmented patches ... 3

2	Ground colour of body dark brown to pale yellow, lateral edges of thorax and abdomen sometime faintly pigmented; antennae not pigmented (Text-fig. 7, A) ...	*D. flavescens* Yosii
	Ground colour of body brown with faint purple blue pigment all over body, Abd. IV with faint longitudinal strands descending from its anterior margin; tergal margins darkest; Ants. I, II, III each with a pigmented distal ring, Ant. IV pigmented almost all along its length (Text-fig. 20, A) ...	*D. indica* (Handschin) n.comb.
3	Pigment absent on Abds. I, II; Abd. IV laterally and lateral extensions of Abd. III at middle with a common and characteristic almost quadrangular darker patch, Abd. IV posteriorly also with a transverse band of same pigment confluent with the lateral patch on Abd. V and shows tendency to be confluent with the anterior lateral patch; Abd. VI devoid of dark pigment, sometime with three circular pale spots, Abds. IV, V dorsomedially nonpigmented; in living specimens, no shining metallic pigment occurs (Text-fig. 14, A, B) ...	*D. gisini* sp.n.
	Abds. III, IV dorsally and/or laterally always with pigmented patches	4
4	Sexually dimorphic in colour pattern; in male, Th. II totally pigmented with reddish blue pigment, Th. III, Abds. I, II laterally with dark pigment, Abd. III with its lateral extensions and Abd. IV totally dark, sometime, posteromedially lighter; females smaller than males and paler in intensity of pigmentation, Th. III, Abd. III and its lateral extensions with violet pigment, lateral margins of Th. III,	

Abds. I, II with or without pigment; Abd. IV laterally on each side with violet pigment but dorsomedially without pigment; pigment not showing tendency to form a distinct, transverse median band on Abd. IV in both sexes; in living specimens shining metallic golden pigment occurs posteriorly on head, Th. II, Abds. I, II and posteromedially on Abd. IV (Text-figs. 1-5 & Pl. 1, A) ...	*D. fasciculatus* Imms
Not sexually dimorphic in colour pattern; males and females pigmented with equal intensity; Th. III, Abds. I, II mostly with dark pigmented patches, median patches on Th. II may be absent, but anterior margin always pigmented; Abd. III and its lateral extensions pigmented; such pigment medially and posteriorly may form two transverse bands on Abd. IV or at least tends to do so, rest of Abd. IV nonpigmented (even in males); no shining metallic pigment occurs in living condition (Text-figs. 18, 19 and Pl. 1, C, D) ...	*D. salmoni* sp.n.

DISCUSSION

Colouration.—Although variation in colour pattern occurs in the species of *Dicranocentroides,* its range is much narrow in comparison to the species of other related genera. *Dicranocentroides fasciculatus* exhibits sexual dimorphism in colour pattern, males being conspicuously darker than females. In *D. gisini* colour pattern is very constant. Further, in all the examples of *D. flavescens* studied, darker pigment pattern is always absent. On the contrary, *D. salmoni* involves various colour-forms and forms with complete transverse bands on Abd. IV are slightly less predominant in comparison to the forms which exhibit tendency of forming such bands on this segment. The colour pattern of head and body can be accepted as an important character owing to its less variation.

Chaetotaxy.—A high degree of variation as to the number and arrangement of macrochaetae on head and body is a striking feature of the genus making it extremely intricate. The number and arrangement of macrochaetae on no tergite is found strictly constant and species-specific. Yosii (1966) in *D. flavescens* considered the chaetotaxy of Abd. II as species-specific. The present findings, however, contradict it since the chaetotaxy of head and body, though reasonably constant in the species like *D. fasciculatus* and *D. gisini,* is extremely variable in *D. flavescens* (Text-figs. 9-13). However, the range of the number of macrochaetae on tergites, Ant. I and medialy on Abd.IV is of some importance in separating the species of the genus.

Chaetotaxy of ventral tube.—Macrochaetae present anteriorly on the anterior face of ventral tube transit into slender microchaetae (*cf. Callyntrura* spp.). Thus, it is difficult to determine the number of macrochaetae of this region of the ventral tube in contrast to the other genera of Paronellinae. Further, anterior and posterior faces of ventral tube are uniformly clothed with microchaetae and number and nature of their distribution do not provide any clue for species-discrimination of this genus.

Dental spines.—A row of spines present on inner margin of each dentes in the species of this genus gradually transits into stiff, ciliated setae distally from *c.* 4/5th of the length of dentes. Such transition of spines, therefore, does not enable to determine the actual number of spines present on each dentes and indicates its importance as a generic character only.

Nature of mucrones.—The species of *Dicranocentroides* possess plump mucrones usually with 6 large teeth. Two teeth (d_1, apical) are mostly round or truncated at apices. Anomaly in the number of mucronal teeth though not infrequent in some species of *Dicranocentroides* (for example, in *D. fasciculatus*), the nature of d_1 and apical teeth is of some importance in the discrimination of the species of this genus. Thus, these teeth are somewhat round in some species e.g., *D. fasciculatus vs.* truncated in *D. argentatus*. Such difference, however, is accepted here as of secondary importance.

Thus, it may be inferred that colour pattern in the species of this genus is relatively more constant than the other characters evaluated here. Further investigations are needed to find out other characters of more specific significance.

SOME ASPECTS OF BIOLOGY

The species of the genus *Dicranocentroides* inhabit moist, shady niches and are found to creep on moist litter in plains and among algae and other herbs and shrubs in foothills. The species of the genus are relatively large in size and therefore, are much conspicuous and exposed to their predators like spiders and pseudoscorpions. It is observed that the species of *Dicranocentroides* usually mimic the neighbouring predator either a pseudoscorpion or a spider in colour pattern and by the gesture of antennae. *D. argentatus* Schött (1925) coexists with certain spiders having almost identical colour pattern and immitates them by stretching and moving constantly the lightly coloured antennae and thereby giving exactly the impression of a spider and its palpi. *D. fasciculatus* possesses dark brown colour with shining golden lustre which corresponds exactly to the colour pattern of a neighbouring species of pseudoscorpion. Moreover, the species, imitating pseudoscorpions, bend their antennae (usually bending occurs at the junction of Ants. III and IV) and move them in such a manner which strikingly corresponds to the movement of chelicerae of pseudoscorpions. *D. flavescens* Yosii, occurring in a shady moist place at Saharanpur, Uttar Pradesh, is found in association with certain lightly coloured brownish pseudoscorpions. *D. gisini* mimics certain pseudoscorpions as well as spiders having darker patches restricted to lateral regions of cephalothorax and mid-dorsally pale. It seems probable that in *Dicranocentroides* the colour pattern of each species is associated with the colour pattern of its predator-neighbour.

SUMMARY

Five species of *Dicranocentroides* Imms are dealt with in this investigation. Of these two species are new to science. *D. fasciculatus f. flavescens* Yosii (1966) is an independent species. *Aphysa indica* Handschin (1929) is a good representative of *Dicranocentroides*. Besides some remarks on biology, a key to the species and a short discussion on taxonomic characters, used for species discrimination, are also incorporated.

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REFERENCES

CARPENTER, G. H. 1917. Collembola : Zoological Results of the Abor expedition, 1911-1912. *Rec. Indian Mus.*, **8** : 561-568.

DELAMARE DEBOUTTEVILLE, C. 1948. Sur *Dicranocentroides coomani* n.sp. et quelques Collemboles récoltés au Tonkin. *Notes ent. Chin.*, **12**(2) : 11-16.

HANDSCHIN, E. 1925. Beiträge zur Collembolenfauna der Sundainseln. *Treubia*, **6** : 225-270.

HANDSCHIN, E. 1929. Beiträge zur Collembolenfauna der Süd-Indien. *Rev. Suisse Zool.*, **36** : 229-262.

IMMS, A. D. 1912. On some Collembola from India, Burma and Ceylon, with a catalogue of the Oriental species of the Order. *Proc. zool. Soc.*, London, 80-125.

PARONA, C. 1892. Di alumni Tisanuri e Collembole della Birmania, raccolti de Leonardo Fea. *Atti. Soc. Ital. Milano*, **34** : 133-154.

PRABHOO, N. R. 1971. Soil and litter Collembola of South India. I-Arthropleona. *Orient. Ins.*, **5**(1) : 1-46.

SALMON, J. T. 1957. Some Paronellinae (Collembola) from India. *Acta Zool. Cracov.*, **11**(14) : 313-362.

SALMON, J. T. 1964. An Index to the Collembola. *Bull. Roy. ent. Soc.*, N.Z., (7) **2** : 145-644.

SCHÖTT, H. 1925. Collembola from Mount Murud and Mount Dulit in Northern Sarwak. *Sarawak Mus. J.*, **3** : 107-127.

YOSII, R. 1956. Monographie zur Höhlencollembolen Japan. *Contr. biol. Lab. Kyoto Univ.*, (3) : 1-109.

YOSII, R. 1966. On some Collembola from Afghanistan, India and Ceylon, collected by Kuphe Expedition, 1960. *Res. Kyoto Univ. Sci. Exped. Karakoram and Hindukush*, 1955, **8** : 333-405.