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Subdivision of the Genus *Chymomyza* CZERNY (Diptera, Drosophilidae), with Description of Three New Species

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Synopsis Using simple taxometric methods, the known species of the genus *Chymomyza* CZERNY of the world is divided into five species-groups and a key to species-groups and species is automatically derived. Three new species of this genus are described from Japan, Taiwan and India. A recent invasion in Japan of a Nearctic species, *C. procnemis* (WILLISTON), is reported.

About 30 species of the genus *Chymomyza* CZERNY have hitherto been described from various parts of the world, few occupying, however, two or more biogeographical regions. Excepting the "*procnemis*-like section" of WHEELER (1949: 163), no subdivision of this genus has been undertaken. The present article attempts a subdivision into several species-groups, by means of simple taxometric analyses, and a subsequent formation of a key to species-groups and species, together with description of three new species and the genital apparata of several species. Recent introduction in Japan of *C. procnemis* (WILLISTON), a Nearctic species, is also reported.

The diagnostic characters of the genus as summarized from OLDENBERG (1914), STURTEVANT (1921), HSU (1949), WHEELER (1952), THROCKMORTON (1962), OKADA (1968), HACKMAN *et al.* (1970), and the present study are as follows.

Eyes bare or sparsely piled. Arista with 3 or 4 upper and 2 or 3 lower branches besides a terminal fork. Anterior reclinate orbital as long as proclinate, situated before proclinate. Postverticals minute. Carina small, limited at the upper part of face. Palpus yellowish. Propleurals often present. Acrostichal hairs in 8 or sometimes 6 rows. Costa reaching the tip of M. Male fore femora often swollen and shaggy, being used for mating and fighting among the same kind of species. Fore tarsi often bicolorous, black and white. Halteres pale. Abdomen slender, tergites glossy black. The flies have habit of constantly waving wings. Epandrium elongate below, surstylus single and small. Aedeagus slender, often bilaterally asymmetrical. Ovipositor yellowish, more or less pointed, with long marginal setae. Eggs with several short filaments. Larvae and puapria with posterior spiracles divergent and basally separated from each other; anterior spiracle with basal rimb extending foreward.

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The holotypes of the new species are deposited at the National Science Museum (Nat. Hist.), Tokyo.

Descriptions

Chymomyza obscura (DE MEIJERE)

(Figs. 1, 2)

Periphallic organs (Fig. 1): Epandrium (g) with the lower rod-like portion very narrow, curved caudally. Surstylus (c) with about 6 marginal and one discal stout black teeth. Phallic organs (Fig. 2): Aedeagus (e) simple, elongate, apically tapering; apodeme (o) very short. Parameres (a) half as long as the lateral arms of hypandrium (a′), with an apical sensillum. Lateral arms of hypandrium apically with several stout hairs.

Specimen examined. 1 ♂, Peradeniya, Ceylon, 17 VIII 1971 (OKADA).

Distribution. Java, Sumatra, Ceylon (new record).

Chymomyza obscuroides sp. n.

(Figs. 3, 4)

♂, ♀. Body black, 1.5–2.5 mm in ♂, 2.0–3.7 mm in ♀. Antenna orange brown, 3rd joint darker; arista with 3 upper and 2 lower branches besides a large terminal fork. Eyes bare. Palpus slender. Clypeus yellowish brown; occiput black. Frons mat black, anteriorly orange. Ocellar triangle and periorbits mat black. Face greyish brown, narrow. Orbitals as usual. Vibrissa rather weak, 2nd oral finer.

Mesoscutum and scutellum mat subshining black. Thoracic pleura slightly paler than mesoscutum, especially pale below wing base and below humerus. One strong humeral. Acrostichal hairs in 8 rows. Legs yellow, femur, tibia and proximal two tarsal joints of fore leg black. Wings hyaline, costa and C-cell black. Wing tip milky white. R_{2+3} straight, R_{4+5} and M convergent distally. C-index about 1.6; 4V-index about 2.3; 4C-index about 1.5; 5x-index about 3.2; Ac-index about

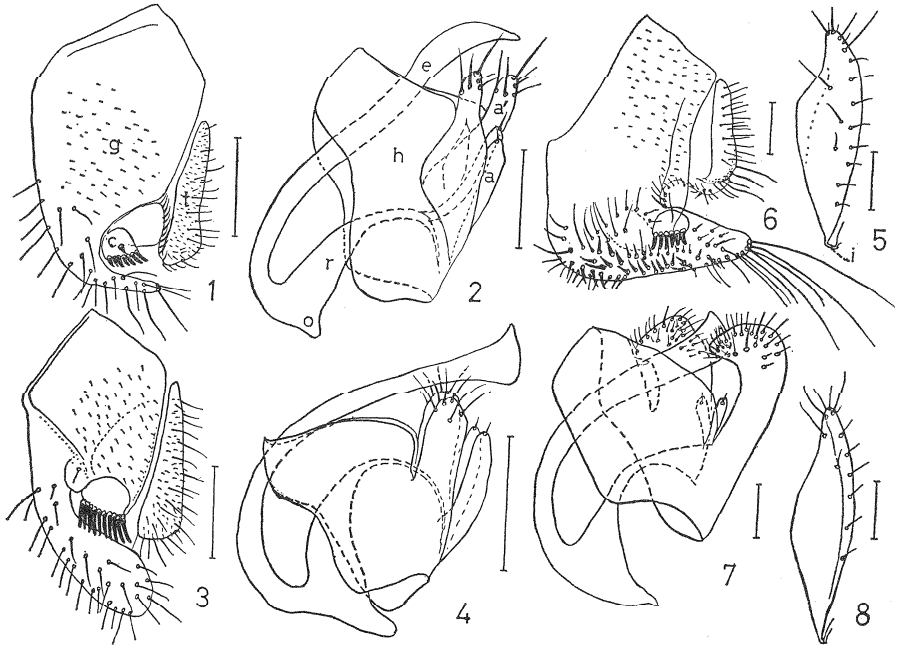
5.0. C3-fringe on basal 2/3. Halteres yellow. Abdominal tergites subshining black.

Periphallic organs (Fig. 3): Epandrium pale brown, ventral portion broad, elliptical, half as broad as the length of upper portion. Surstylus with about 10 black teeth. Phallic organs (Fig. 4): Aedeagus slender, pale brown, bilaterally symmetrical, gently curved dorsoventrally, apically broadened and truncate. Parameres (a) nearly as long as lateral arms of hypandrium (a'), apically with a sensillum. Ovipositor (Fig. 5) yellowish brown, apically obtusely pointed, with about 10 long setae; basal isthmus (i) very short.

Holotype: ♂, Yatsushiro, Kumamoto Pref., 12 IX 1971 (Kanmiya). Allotype: ♀, Asakawa, Tokyo, 27. VIII. 1975 (Nishiharu, from stump of *Alnus*). Paratypes: 1 ♂, 1 ♀, collected together with allotype; 1 ♂, Kamikawa, Mie Pref., 21. X. 1960 (Okada); 1 ♀, Inokashira, Tokyo, 3. XI. 1953 (Ikuma).

Distribution. Japan: Honshu (Kanto, Chubu), Kyushu.

Relationships. Resembles *C. obscura* (de Meijere) in having body black, costa



Figs. 1–2. *Chymomyza obscura* (de Meijere); 1, periphallic organs; 2, phallic organs. —— 3–5. *C. obscuroides* Okada, n. sp.; 3, periphallic organs; 4, phallic organs; 5, ovipositor. —— 6–8. *C. formosana* Okada, n. sp; 6, periphallic organs; 7, phallic organs; 8, ovipositor. a, paramere; a', lateral arm of hypandrium; c, surstylus; e, aedeagus; g, epandrium; h, hypandrium; i, basal isthmus of ovipositor; o, apodeme of aedeagus; r, vetrical rod of aedeagus; t, cercus. Scales 0.1 mm.

and C-cell black, and wing tip milky white, but differs in having basal two tarsal joints of fore leg black (2nd taral joint pale in *obscura*), and C-index higher.

Remarks. The female specimen recorded by me (1956: 60) as *C. costata* ZETTERSTEDT belongs to this species.

Chymomyza formosana sp. n

(Figs. 6–8)

♂, ♀. Body about 3 mm in length. Eyes bare. Antenna with 2nd joint dark brown, 3rd yellowish, darker above. Arista with 3 upper and 2 lower branches besides a large terminal fork. Palpus slender, yellow. Clypeus whitish. Front flat, mat black, with blue pollinosity, anterior margin orange. Ocellar triangle glossy black, periorbits convexed, black. Occiput black. Face greyish white; cheek narrow, yellowish grey. 2nd oral half vibrissa.

Mesoscutum, scutellum and thoracic pleura mat black, with blue pollinosity; humeral callus and above wing base dark brown. Humerals 2, short. Acrostichal hairs in 6 rows. Anterior scutellars divergent, half as long as posteriors, which are divergent and slightly nearer to anteriors than to each other. Sterno-index 0.6. Legs yellow, femur, tibia, and metatarsus of fore leg black. Wings hyaline, apically milky white, costa and C-cell black. R_{2+3} straight, R_{4+5} and M convergent. C-index about 1.3; 4V-index 2.0; 4C-index 1.5; 5x-index 3.0; Ac-index 3.8. C3-fringe on basal 4/5. Halteres white. Abdominal tergites uniformly mat subshining black.

Periphallic organs (Fig. 6): Epandrium robust, black, lower portion curved caudally, distally tapering, with a few very long hairs apically and numerous bristles anteriorly. Surstylus with about 6 black teeth. Phallic organs (Fig. 7): Aedeagus slender, gently curved dorsoventrally, apically broadened and truncate. Parameres small. Lateral arms of hypandrium robust, apically hooked and shaggy. Ovipositor (Fig. 8) pale yellow, apically pointed, marginally with about 10 long setae. Basal isthmus very short.

Holotype ♂, allotype ♀, and 28 ♂ and 18 ♀ paratypes, Chitau, Nantou Prov., Taiwan, 16–17. VIII. 1967 (OKADA, from timber piles of *Cryptomeria*).

Distribution. Taiwan.

Relationships. Resembles the foregoing species, *obscuroides*, in having black body, white tip of wing, black costa and C-cell, and slender aedeagus, but differs in having fewer surstylus teeth and black 2nd tarsal joint of fore legs.

Chymomyza costata (ZETTERSTEDT)

(Fig. 18)

Periphallic organs as figured by HACKMAN *et al* (1970). Surstylus with about 10 long black teeth. Phallic organs (Fig. 18): Aedeagus slender, gently curved dorsoventrally, apically much broadened, bilaterally symmetrical. Parameres small, with two apical sensilla. Lateral arms of hypandrium robust, marginally

with about 5 long setae.

Specimens examined. 1 ♂, Miltonbridge, Midlothian, Scotland, 23 VIII 1951 (BASDEN); 1 ♂, 1 ♀, N. Esbo Kolmperä, Finland, 21. VIII. 1968 (HACKMAN); 1 ♂, Prov. Ryang-gang, Chann-Pay plateau, Sam-zi-yan, N. Korea, 28. VIII. 1971. (PAPP), as recorded by me (1974b: 269).

Distribution. Europe, N. Korea.

Chymomyza vaidyai sp. n.

(Figs. 9, 10)

This species was described by VAIDYA and GODBOLE (1973) under the name *C. pararufithorax*, which is, however, unavailable as it appeared in Dros. Inf. Serv. This does not constitute a publication within the meaning of the International Code of Zoological Nomenclature.

♂. Body 2.5 mm in length. Eyes bare. Antenna yellowish brown, 3rd darker. Arista with 3 upper and 2 lower branches besides a large terminal fork. Palpus orange yellow. Clypeus yellow. Frons orange grey, anteriorly orange yellow. Ocellar triangle black; periorbits grey, with whitish pollinosity. Face yellow, carina undeveloped. Cheek yellow, very narrow. Proclinate orbitals slightly shorter than others. Second oral 2/3 vibrissa, a few succeeding orals as long as the 2nd.

Mesoscutum orange brown, scutellum darker. Thoracic pleura black above, pale below. Humerals two, upper one very short. Acrostichal hairs in about 8 rows. Anterior dorsocentrals half posteriors. Sterno-index about 0.8. Legs yellowish white; fore leg with femur, tibia and metatarsus black; knee joint yellow. Wings hyaline, costa and C-cell black. C-index about 1.8; 4V-index about 2.2; 4C-index about 1.4; 5x-index about 3.3; Ac-index about 3.4. C3-fringe on basal 3/4. Halteres yellow. Abdominal tergites glossy black.

Periphallic organs (Fig. 9) pale brown. Epandrium with lower portion broad, elliptical, the diameter nearly equal to upper width. Surstylus with about 7 teeth. Phallic organs (Fig. 10): Aedeagus slender, gently curved dorsoventrally, apically broadened and truncate. Parameres large, nearly equal in size to the lateral arms of hypandrium.

Holotype: ♂, Poona, Maharashtra, India, 31. VII. 1971, (VAIDYA and GODBOLE).

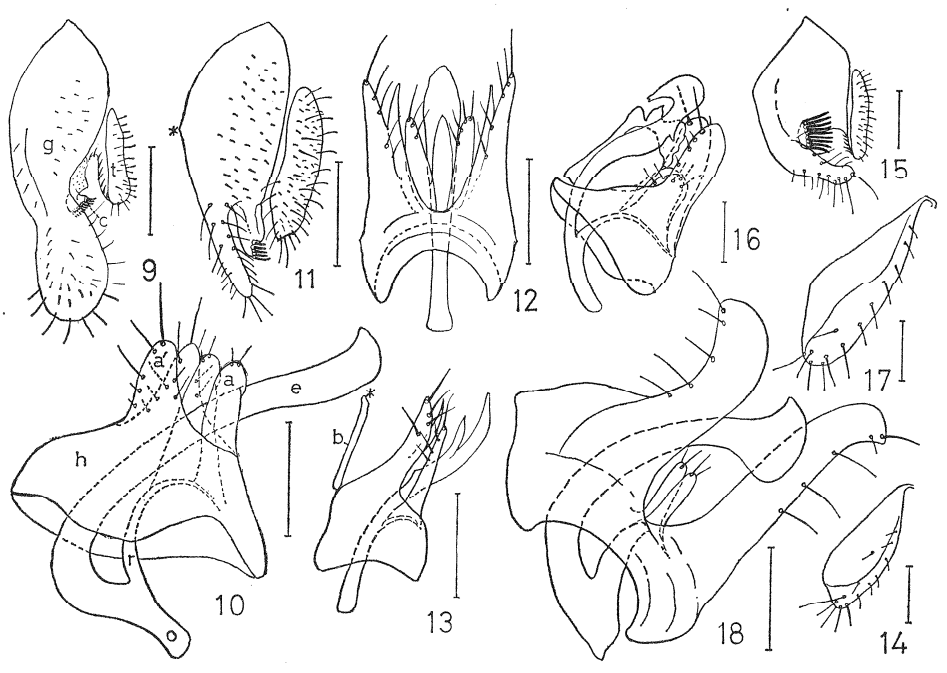
Distribution. India.

Relationships. Resembles *C. rufithorax* (DE MEIJERE) in having frons, face and mesoscutum yellowish orange, wing tip white and costa and C-cell black, but distinguished by higher C-index and black 2nd tarsal joint of fore leg.

Chymomyza procnemis (WILLISTON)

(Figs. 11–14)

Periphallic organs (Fig. 11); as described and figured by HSU (1949), except that surstylus has 4 or 5 teeth in all of the examined specimens (7 or 8 by HSU; see re-



Figs. 9–10. *Chymomyza vaidyai* OKADA, n. sp.; 1, periphallic organs; 2, phallic organs. —— 11–14. *C. procnemis* (WILLISTON); 11, periphallic organs; 12, 13, phallic organs; 14, ovipositor. —— 15–17. *C. amoena* (LOEW); 15, periphallic organs; 16, phallic organs; 17, ovipositor. —— 18. *C. costata* (ZETTERSTEDT), phallic organs. b, bar connecting hypandrium to epandrium; other signs and scales as in Figs. 1–8.

marks).

Phallic organs (Figs. 12, 13): Aedeagus slender, with a ventral branch. Parameres slender, distally with a few long setae, slightly shorter than the lateral arms of hypandrium, which are pointed, setigerous, and distally bifid. A rod-like bar (b) connecting hypandrium to the lateral corner of epandrium. Ovipositor (Fig. 14) with several long marginal setae.

Specimens examined. Stock from 2 female flies collected at a green market, Sugamo, Tokyo, 1 and 2. IX. 1972, (YAMAURA), in the boxes of melon fruits imported from California through Los Angeles: stock, Omaezaki, Shizuoka Pref., 10. VII. 1972, (TSUNO, at lumber yard; sent from KANEKO); stock, Kawasaki, Kanagawa Pref., 11. VIII. 1974, (OHBA, at lumber yard; sent from KANEKO); stock, Shiogama, Miyagi Pref., 12. IX. 1974, (OHBA, at lumber yard; sent from KANEKO); 1 ♂, Kitakyushushi, 16. X. 1973, (UEDA, at fruit trap); 9 ♂, 9 ♀ from stock, UT No. 2150. 6, Fort Davis, Texas (WHEELER).

Distribution. N. America, St. Vincent Is., Neotropical Region, Hawaii, Japan (Tohoku, Kanto, Chubu, Kyushu) (new record).

Remarks. According to Dr. WHEELER's personal communication, HSU had mistaken the number of surstylus teeth. The HSU's original slide mount of male genitalia (stock, Galveston, Texas), which Dr. WHEELER kindly lent me, showed the number 4–6 (4, 4, 5, 6, 6, 6 in six pieces of the periphallic organs), similar to that in the forms of Japan and Fort Davis.

It is remarkable that this species has recently invaded Japan from N. America and spread quickly in various parts of Japan.

Chymomyza amoena (LOEW)

(Figs. 15–17)

Periphallic organs (Fig. 15) as figured and described by HSU (1949), but his figure shows surstylus inverted. Phallic organs (Fig. 16): Aedeagus brown, asymmetrical, distally swollen and irregularly bilobed. Parameres broad but short, much shorter than the lateral arms of hypandrium, which are paler than and as broad as parameres. Both parameres and lateral arms distally with several long setae. Ovipositor (Fig. 17) pale, apically obtuse, marginally with more than ten long setae.

Specimens examined. 8 ♂, 1 ♀, Ashville, North Carolina, 3–4. V. 1969, (OKADA).

Taxometric Analyses

Simple methods of taxometry, proximity and cluster analyses, are used for finding the relationships between the species and for attempting subdivision of the genus into species-groups. In the first place following twelve species, for which sufficient informations of male genital armatures as well as of external diagnostic characters are available, will be taken into consideration. They have been examined by myself except for *C. distincta*, which is cited especially from DUDA (1935, under *nigrimana*) and HACKMAN *et al.* (1970).

	Species	Distribution	Material examined
1.	*C. obscura* (DE MEIJERE, 1911)	Java, Sumatra, Ceylon	Peradenia, Ceylon
2.	*C. formosana* OKADA, this study	Taiwan	Chitau
3.	*C. obscuroides* OKADA, this study	Japan	Honshu, Kyushu
4.	*C. procnemis* (WILLISTON, 1896)	N. America, Neotropical, Hawaii, Japan	Texas, Honshu, Kyushu
5.	*C. fenestrata* OKADA, 1973	Japan	Bonins
7.	*C. vaidyai* OKADA, this study	India	Poona
14.	*C. fuscimana* (ZETTERSTEDT, 1838)	Europe, Japan	Hokkaido, Honshu
15.	*C. distincta* (EGGER, 1862)	Europe	
18.	*C. amoena* (LOEW, 1862)	N. America	N. Carolina

19.	*C. caudatula* OLDENBERG, 1914	Europe, Japan, N. America	Hokkaido
24.	*C. costata* (ZETTERSTEDT, 1838)	Europe, Korea	Scotland, Finland, N. Korea
25.	*C. japonica* OKADA, 1956	Japan	Honshu

Seventeen mostly highly diagnostic characters (expressed by large letters) are chosen, each divided into two states, presumably plesiomorphic state (also large letter) and presumably apomorphic state (small letter), which are coded 0 and 1, respectively. The presumably apomorphic state of character D_2 of *C. japonica* is exceptionally coded 0.5, because the 2nd tarsal joint of fore leg is proximally black and distally white.

	Characters	Presumably plesiomorphic state	Presumably apomorphic state
A.	Frons	blackish (A)	yellowish (a)
B.	Face	blackish (B)	yellowish (b)
C.	Mesoscutum	blackish (C)	yellowish (c)
D_1.	Metatarsus of fore leg	yellowish (D_1)	blackish (d_1)
D_2.	2nd tarsal joint of fore leg	yellowish (D_2)	blackish (d_2)
D_5.	5th tarsal joint of fore leg	yellowish (D_5)	blackish (d_5)
E.	Wing tip	not milky white (E)	milky white (e)
F.	Costal cell	hyaline (F)	black (f)
G.	C-index	about 1.0 (G)	more than 1.5 (g)
H.	4th vein index	about 3.0 (H)	less than 2.5 (h)
I.	Ac-index	about 3.8 (I)	more than 4.0 (i)
J.	Surstylus teeth	less than eight (J)	more than ten (j)
K.	Lower elongate portion of epandrium	broad, half or more of upper portion (K)	narrow, less than 1/4 upper portion (k)
L.	Aedeagus	bilaterally symmetrical (L)	bilaterally asymmetrical (l)
M.	Phallosomal index (PI)	less than 3.0 (M)	more than 3.5 (m)
O.	Wing marking below tip of R_{2+3}	absent (O)	present (o)
P.	Wing marking upon posterior crossvein	absent (P)	present (p)

From the original species × character data matrix–I (Table 1), the cladogram–I (Fig. 19) is obtained, adopting SCD proximity analysis (Okada, 1974a) and ordinary UPGA cluster analysis. Then the characters discriminating the major stems of the cladogram–I are chosen from the original data matrix–I and put their states on the corresponding stems by means of HENNIG's expression of white and black bars, which indicate plesiomorphic and apomorphic states, respectively. The discriminative characters thus chosen are D_1, E, L, A and C. As a result the twelve species are

divided into four major groups, I (characterized by ACd_1 eL), II (acd_1 eL), III (acD_1 el), and IV (ΛCd_1 E, L or l).

In the second place, eighteen known species as listed below, which are not examined by myself but cited from literature, are added to the first twelve species. *C. maculipennis* HENDEL, 1936, and *C. pectinifemur* DUDA, 1927, are excluded from the list, because they are thought synonymous with *C. bicoloripes* MALLOCH by WHEELER (1957: 102) and *C. procnemis* (WILLISTON) by DUDA (1927: 68), respectively. *C. nigrimana* (MEIGEN, 1830) is also not entered, as its true identity is uncertain according to BASDEN (1961: 172). In this connection, the Japanese species reported as *C. nigrimana* by myself (1956: 61) is identical with *C. fuscimana* (ZETTERSTEDT) according to BASDEN (1965: 5).

	Species	Distribution
6.	*C. rufithorax* (DE MEIJERE, 1911)	Java, Sumatra
8.	*C. cinctifrons* DE MEIJERE, 1924	Sumatra
9.	*C. bicolor* LAMB, 1914	Seychelles
10.	*C. lahu* BURLA, 1954	Africa
11.	*C. avikam* BURLA, 1954	Africa
12.	*C. mafu* BURLA, 1954	Africa
13.	*C. bambara* BURLA, 1954	Africa
16.	*C. olympia* WHEELER, 1960	N. America
17.	*C. wirthi* WHEELER, 1954	N. America, Alaska
20.	*C. laevilimbata* DUDA, 1927	S. America
21.	*C. procnemoides* WHEELER, 1952	N. & S. America
22.	*C. mesopecta* WHEELER, 1968	S. America
23.	*C. coxata* WHEELER, 1952	N. America, Alaska
26.	*C. atrimana* OKADA, 1956	Japan
27.	*C. mexicana* WHEELER, 1949	C. America, Mexico
28.	*C. aldrichii* STURTEVANT, 1916	N. America
29.	*C. leucopoda* WHEELER, 1949	Mexico
30.	*C. bicoloripes* (MALLOCH, 1926)	C. America

Due, however, to poor informations concerning male genital characters of these species, the previously adopted genital characters, J. K, L and M, are omitted in the original species × character data matrix–II (Table 2). Even then, some NC (no comparisons) are involved in this matrix, so that as the proximity analysis MCD method (CAIN and HARRISON, 1958) will be adopted instead of SCD method. In this matrix the characters A, C, D_1 and E, which are previously found to be most discriminative, are counted twice so as to give them double weighting. As the cluster analysis, UPGA method is used as before. Thus, from the original matrix–II the cladogram–II is obtained (Fig. 20). The characters which discriminate the major clusters in the cladogram–II are selected from the original data matrix–II and put on the corresponding stems of the cladogram by mean of white and black bars of HENNIG, as adopted before. They are A, C, D_1 and E, which are same as have been

Table 1. Original data matrix–I. The characters are codded into two states, 0 and 1 for the presumably plesiomorphic and presumably apomorphic states, respectively.

Character	A	B	C	D_1	D_2	D_5	E	F	G	H	I	J	K	L	M	O	P
Specirs																	
1	0	1	0	1	0	0	1	1	0	1	1	0	0	0	1	0	0
2	0	1	0	1	0	0	1	1	0	1	0	0	0	0	1	0	0
3	0	0	0	1	1	0	1	1	1	1	1	1	0	0	1	0	0
4	1	0	1	1	0	0	1	1	0	1	1	0	1	0	0	0	0
5	1	0	1	1	0	0	1	1	0	1	1	1	0	0	1	1	0
7	1	1	1	1	0	0	1	1	1	1	0	0	0	0	1	0	0
14	1	1	1	0	0	0	1	1	1	0	0	1	0	1	0	1	0
15	1	1	1	0	0	0	1	1	1	0	0	0	0	1	0	1	0
18	1	1	1	0	0	0	1	1	1	0	0	1	1	1	0	1	1
19	0	1	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0
24	0	1	0	1	1	1	0	1	1	1	0	1	1	0	0	0	0
25	0	1	0	1	0.5	0	0	0	1	1	0	0	1	1	0	0	0

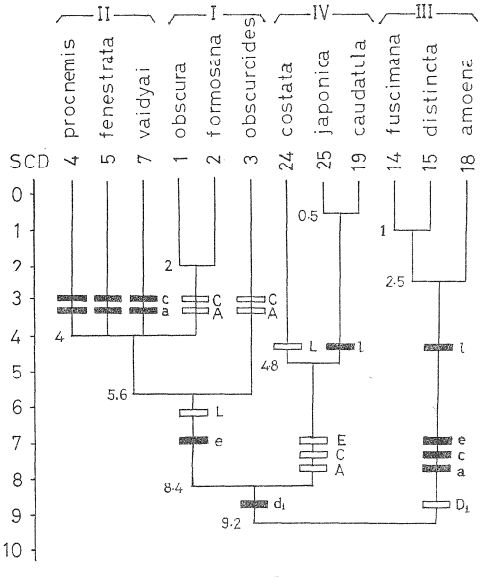


Fig. 19. Cladogram–I. of 12 species of *Chymomyza*, based on SCD proximity analysis and UPGA cluster analysis. White cross bars and large letters on the stems are presumably plesiomorphic character states; black cross bars and small letters on the stems are presumably apomorphic character states.

Table 2. Original data matrix–II. The characters are coded into two states, 0 and 1 for the presumably plesiomorphic and presumably apomorphic states, respectively. The charcters A, C, D_1, and E are counted twice to give them doule weighting.

Character	A	A	B	C	C	D_1	D_1	D_2	D_5	E	E	F	G	H	O	P
Species																
1, 2	0	0	1	0	0	1	1	0	0	1	1	1	0	1	0	0
3	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	0
4, 10, 12, 13	1	1	1	1	1	1	1	0	0	1	1	1	0	1	0	0
5	1	1	0	1	1	1	1	0	0	1	1	1	0	1	1	0
6	1	1	1	1	1	1	1	1	0	1	1	1	0	NC	0	0
7, 11	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0
8	1	1	NC	1	1	1	1	0	0	1	1	NC	0	1	0	0
9	1	1	1	1	1	1	1	0	0	1	1	0	0	1	0	0
14, 15, 16	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0
17	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
18	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1
19	0	0	1	0	0	1	1	0	0	0	0	0	1	1	0	0
24	0	0	1	0	0	1	1	1	1	0	0	1	1	1	0	0
25	0	0	1	0	0	1	1	0.5	0	0	0	0	1	1	0	0
26	0	0	1	0	0	1	1	1	0	0	0	0	1	1	0	0
27	0	0	1	0	0	1	1	1	0	0	0	1	1	0	0	0
29	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0
20	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	0
21	1	1	1	1	1	1	1	0	0	0	0	1	1	1	0	0
22	1	1	1	1	1	1	1	0	0	0	0	1	1	NC	0	0
23	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	0
28	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0
30	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	1

weighted twice. The additional discriminative characters are shown in the cladogram by large and small letters put on the corresponding stems. As a result five major groups, I–V, are recognized; I–IV are same as obtained before and V is newly added. They will be treated as the species groups I (characterized by ACd_1 e), II (acd_1 e), III (acD_1 e), IV (ACd_1 E), and V (acd_1 E), and are named *obscura, procnemis, fuscimana, costata*, and *aldrichii* species-groups, respectively.

Subdivision into Species-groups

I. *The* obscura *species-group*

Frons and mesoscutum blackish (A, C). Wing tip milky white (e). Fore leg with tarsi bicolorous, at least metatarsus black (d_1). Aedeagus bilaterally symmetrical (L) so fas as examined.

Species included: *obscura* (DE MEIJERE), *formosana* OKADA, *obscuroides* OKADA.

II. *The* procnemis *species-group*

Frons and mesoscutum yellowish brown (a, c). Wing tip milky white (e). Fore

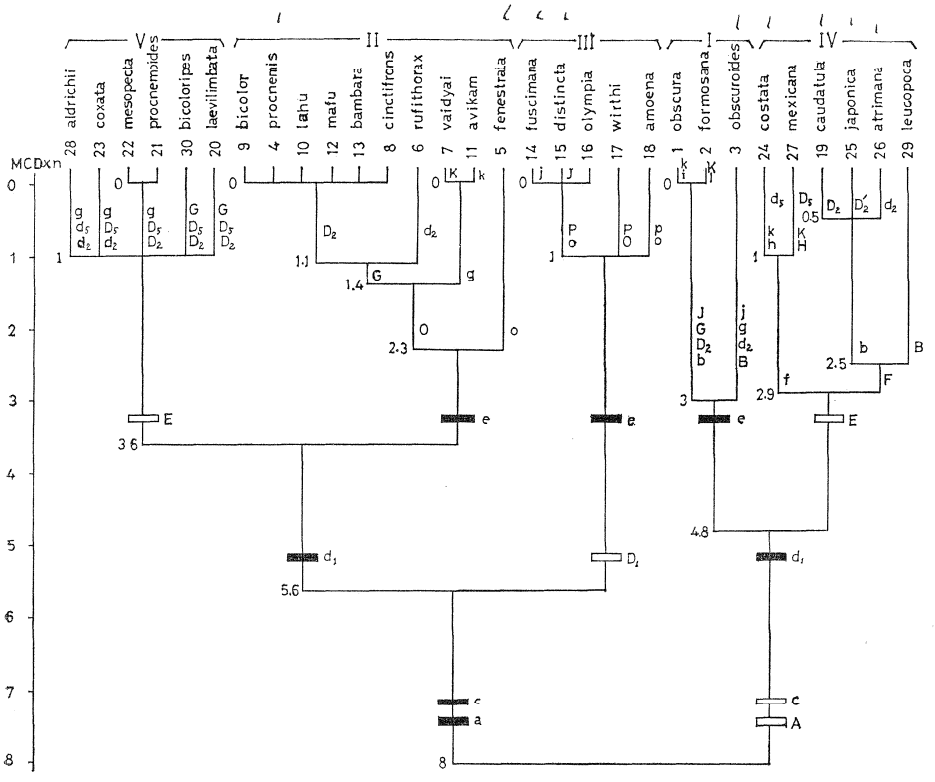


Fig. 20. Cladogram–II of 30 species of *Chymomyza*, based on MCD proximity analysis and UPGA cluster analysis. Bars and signs on the stems as in Fig. 19.

leg with tarsi bicolorous, at least metatarsus black (d_1). Aedeagus bilaterally symmetrical (L) so far as examined.

Species included: *procnemis* (WILLISTON), *fenestrata* OKADA, *rufithorax* (DE MEIJERE), *vaidyai* OKADA, *cinctifrons* DE MEIJERE, *bicolor* LAMB, *lahu* BURLA, *avikam* BURLA, *bambara* BURLA.

III. *The* fuscimana *species-group*

Frons and mesoscutum yellowish brown (a, c). Wing tip milky white (e). Fore leg with tarsi unicolorous, metatarsus not black (D_1). Aedeagus bilaterally asymmetrical (l) so far as examined.

Species included: *fuscimana* (ZETTERSTEDT), *distincta* (EGGER), *olympia* WHEELER, *wirthi* WHEELER, *amoena* (LOEW).

IV. *The* costata *species-group*

Frons and mesoscutum blackish (A, C). Wing tip not milky white (E). Fore leg with tarsi bicolorous, at least metatarsus black (d_1). Aedeagus bilaterally symmetrical or asymmetrical (L or l).

Species included: *costata* (ZETTERSTEDT), *caudatula* OLDENBERG, *japonica* OKADA, *atrimana* OKADA, *mexicana* WHEELER, *leucopoda* WHEELER.

V. *The* aldrichii *species-group*

Frons and mesoscutum yellowish brown (a, c). Wing tip not milky white (E). Fore leg with tarsi bicolorous or entirely black, at least metatarsus black (d_1).

Species included: *aldrichii* STURTEVANT, *laevilimbata* DUDA, *procnemoides* WHEELER, *mesopecta* WHEELER, *bicoloripes* (MALLOCH).

Key to the Species-groups and Species, derived from the Cladogram

From the procedure of selecting discriminative characters taken above, a key to species-groups and species will be automatically derived as shown below. Those closely related species, clustered at 0 level in the cladogram–II, are discriminated by further characters found in literature, especially in the keys presented by various authors: OLDENBERG (1914, 18), STURTEVANT (1921, 61), DUDA (1924, 226; 1927, 64; 1935, 41), WHEELER (1949, 164; 1952, 174), BURLA (1954, 15), OKADA (1965, 60), and HACKMAN *et al.* (1970, 1).

1. Frons and mesoscutum blackish (A, C). Fore leg with metatarsus black (d_1) 2
— Frons and mesoscutum yellowish (a, c) 3
2. Wing tip milky white (e) ..... *obscura* group 5
— Wing tip not milky white (E) ..... *costata* group 20
3. Fore leg with metatarsus not black (D_1). Wing tip milky white (e) ..... *fuscimana* group 19
— Fore leg with metatarsus black (d_1) 4
4. Wing tip milky white (e) ..... *procnemis* group 7
— Wing tip not milky white (E) ..... *aldrichii* group 25

I. The *obscura* species-group

5. Face blackish (B). Fore leg with 2nd tarsal joint black (d_2). C-index more than 1.0 (g). Surstylus teeth more than ten (j) ..... *obscuroides*
— Face yellowish brown (b). Fore leg with 2nd tarsal joint not black (D_2). C-index about 1.0 (G). Surstylus teeth less than eight (J) 6
6. Ac-index about 3.0 (I). Epandrium with lower elongate portion broad (K). ..... *formosana*
— Ac-index more than 4.0 (i). Epandrium with lower elongate portion narrow (k). ..... *obscura*

II. The *procnemis* species-group

7. Wing with a large black marking below tip of R_{2+3} (o) ..... *fenestrata*
— Wing without black marking below tip of R_{2+3} (O) 8
8. C-index more than 1.5 (g) 9

— C-index about 1.0 (G)....10
9. Epandrium with lower elongate portion broad (K)....*vaidyai*
— Epandrium with lower elongate portion narrow (k)....*avikam*
10. Fore leg with 2nd tarsal joint black (d_2)....*rufithorax*
— Fore leg with 2nd tarsal joint yellow (D_2)....11
11. Frons medially with a black cross band....*cinctifrons*
— Frons medially without black cross band....12
12. Costal cell hyaline (F)....*bicolor*
— Costal cell blackish (f)....13
13. Lower elongate portion of epandrium without long hairs....14
— Lower elongate portion of epandrium with long hairs....15
14. Acrostichal hairs in 8 rows....*procnemis*
— Acrostichal hairs in 6 rows....*bambara*
15. Face brown. Mesoscutum uniformly glossy dark brown....*mafu*
— Face yellowish white. Mesoscutum pale brown with dark brown median longitudinal stripe....*lahu*

III. The *fuscimana* species-group

16. Wing with prominent large black markings, one below tip of R_{2+3} (o) and another over posterior crossvein (p)....*amoena*
— Wing without prominent balck marking over posterior crossvein (P)....17
17. Wing without black marking below tip of R_{2+3} (O). Female fore leg darker than in male....*wirthi*
— Wing usually with a black marking below tip of R_{2+3} (o). Female fore leg as pale as in male....18
18. Face with a broad black cross band below....*olympia*
— Face without black cross band below....19
19. Surstylus teeth more than ten (j)....*fuscimana*
— Surstylus teeth less than eight (J)....*distincta*

IV. The *costata* species-group

20. Costal cell balckish (f)....21
— Costal cell pale (F)....22
21. Fore leg with 5th tarsal joint black (d_5). 4V-index less than 2.5 (h). Epandrium with lower elongate portion narrow (k)....*costata*
— Fore leg with 5th tarsal joint pale (D_5). 4V-index about 3.0 (H). Epandrium with lower elongate portion broad (K)....*mexicana*
22. Face blackish (B)....*leucopoda*
— Face yellowish brown (b)....23
23. Fore leg with 2nd tarsal joint pale (D_2)....*caudatula*
— Fore leg with 2nd tarsal joint at least partially black....24

24. Fore leg with 2nd tarsal joint proximally black and distally yellow (D_2)..... ..... *japonica*
— Fore leg with 2nd tarsal joint entirely black (d_2)..... *aurimana*

V. The *aldrichii* species-group

25. Fore leg with 2nd tarsal joint black (d_2)..... 26
— Fore leg with 2nd tarsal joint pale (D_2), 5th also pale (D_5)..... 27
26. Fore leg with 5th tarsal joint pale (D_5). Fore coxa of ♂ heavily long-haired along inner surface..... *coxata*
— Fore leg with 5th tarsal joint black (d_5). Fore coxa of ♂ without long hairs. C-index more than 1.5 (g)..... *aldrichii*
27. C-index about 1.0 (G) 28
— C-index more than 1.5 (g) 29
28. Posterior crossvein conspicuously clouded..... *bicoloripes*
— Posterior crossvein not clouded..... *laevilimbata*
29. Wing hyaline. Body up to 2.5 mm in length..... *procnemoides*
— Wing darkened along the apex of R_{2+3}. Body up to 3 mm in length. . *mesopecta*

Summary

The subdivision of the genus *Chymomyza* CZERNY is attempted basing upon the cladograms obtained by simple taxometric methods, which resulted in the establishment of five species-groups: I. *obscura* group, II. *procnemis* group, III. *costata* group, IV. *fuscimana* group, and V. *aldrichii* group. Key to species-groups and species of the world is derived from the original data matrices and the cladograms. Three new species are described: *C. obscuroides* from Japan, *C. formosana* from Taiwan, and *C. vaidyai* from India. A recent invasion into Japan of a New World species, *C. procnemis* (WILLISTON), is reported. The male genital apparata are described for several species. *C. costata* (ZETTERSTEDT) is newly recorded from Ceylon.

Literature

BASDEN, E. B., 1956. Drosophilidae (Diptera) within the Arctic Circl. I. General survey. *Trans. R. ent. Soc. Lond.*, **108**: 1–20.

——— 1961. Type collections of Drosophilidae (Diptera). 1. The Strobl collection. *Beitr. Ent.*, **11**: 160–224.

BURLA, H., 1954. Zur Kenntnis der Drosophiliden der Elfenbeinküste (Französisch West-Africa). *Rev. suis. Zool.*, **61** (Suppl.): 1–218.

CAIN, A. J., and G. A. HARRISON, 1958. An analysis of the taxonomists's judgement of affinity. *Proc. zool. Soc. Lond.*, **131**: 85–98.

DUDA, O., 1924. Beitrag zur Systematik der Drosophiliden unter besonderer Berücksichtigung der paläarktischen u. orientalischen Arten (Dipteren). *Arch. Naturg.*, **90A** (3): 172–234, 7 pls.

——— 1927. Die südamerikanischen Drosophiliden (Dipteren) unter Berücksichtigung auch der anderen neotropischen sowie der nearktischen Arten. *Ibid.*, **91A** (11–12): 1–228.

DUDA, O., 1935. Drosophilidae, *In Lindner*, E., *Die Fliegen der palaearktischen Region*, **58g**: 1–118, 5 pls.

HACKMAN, W., S. LAKOVAARA, A. SAURA, M. SORSA and K. VEPSÄLÄINEN, 1970. On the biology and karyology of *Chymomyza costata* ZETTERSTEDT, with reference to the taxonomy and distribution of various species of *Chymomyza* (Dipt., Drosophilidae). *Ann. ent. fenn.*, **36**: 1–9.

HSU, T. C., 1949. The external genital apparatus of male Drosophilidae in relation to systematics. *Univ. Texas Publ.*, (4920): 80–142, 18 pls.

LAMB, C. G., 1914. Diptera: Heteroneuridae, Ortalidae, Trypetidae, Sepsidae, Micropezidae, Drosophilidae, Geomyzidae, Milichidae. Percy Sladen Trust Expedition, Indian Ocean 1905. *Trans. Linn. Soc. Lond.*, (2-Zoology), **16**: 307–372, 3 pls.

MEIJERE, J. C. H. de., 1911. Studien über südostasiatische Dipteren VI. *Tijdschr. Ent.*, **54**: 258–432, 5 pls.

———— 1924. Studien über südostasiatische Dipteren XV, Dritter Beitrag zur Kenntnis der sumatranischen Dipteren. *Ibid.*, **67** (Suppl.): 1–64.

OKADA, T., 1956. Systematic Study of Drosophilidae and Allied Families of Japan. 183 pp. Gihodo, Tokyo.

———— 1968. Systematic Study of the Early Stages of Drosophilidae. 188 pp. Bunka Zugeisha, Tokyo.

———— 1971. Systematic and biogeographical analyses of the *denticeps* group with description of two new species (Diptera, Drosophilidae). *Bull. biogeogr. Soc. Jap.*, **26**: 29–38.

———— 1973. Descriptions of four new species of Drosophilidae of the Bonins, with taxometrical analyses of the *Scaptomyza* species (Diptera). *Kontyû, Tokyo*, **41**: 83–90.

———— 1974 a. A revision and taxometric analysis of the genera *Sphaerogastrella* DUDA and *Liodrosophila* DUDA of the world (Diptera, Drosophilidae). *Mushi*, **48**: 29–63.

———— 1974 b. Drosophilidae (Diptera) from Korea. *Annls. hist.-nat. Mus. natn. hung.*, **66**: 269–275.

OLDENBERG, L. 1914. Beitrag zur Kenntnis der europäischen Drosophiliden (Dipt.). *Arch. Naturg.*, **80A** (2): 1–12.

STURTEVANT, A. H., 1916. Note on North American Drosophilidae, with descriptions of twenty-three new species. *Ann. ent. Soc. Amer.*, **9**: 323–343.

———— 1921. The North American species of *Drosophila*. *Carnegie Inst. Wash., Publ.*, (301): 1–150.

THROCKMORTON, L. H., 1962. The problem of phylogeny in the genus *Drosophila*. *Univ. Texas Publ.*, (6205): 207–343.

VAIDYA, V. G., and N. N. GODBOLE, 1973. First report of genus *Chymomyza* (Drosophilidae) from India: *Chymomyza pararufithorax* sp. nov. *Dros. Inf. Serv.*, (50): 71–72.

WHEELER, M. R., 1949. Taxonomic studies on the Drosophilidae. *Univ. Texas Publ.*, (4920): 157–195.

———— 1952. The Drosophilidae of the Nearctic Region, exclusive of the genus *Drosophila*. *Ibid.*, (5208): 162–218.

———— 1954. Taxonomic studies on American Drosophilidae. *Ibid.*, (5422): 47–64.

———— 1957. Taxonomic and distributional studies of Nearctic and Neotropical Drosophilidae. *Ibid.*, (5721): 79–114.

———— 1960. Three new North American Drosophilidae. *Southwest. Naturalist*, **5**: 89–91.

———— 1968. Some remarkable new species of Neotropical Drosophilidae. *Univ. Texas Publ.*, (6818): 431–442.

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