Ann. Ent. Fenn. 36: 1. 1970. p. 1—9

On the biology and karyology of Chymomyza costata Zetterstedt, with reference to the taxonomy and distribution of various species of Chymomyza (Dipt., Drosophilidae)

WALTER HACKMAN, SEPPO LAKOVAARA, ANSSI SAURA, MARJA SORSA and KARI VEPSÄLÄINEN.

Zoological Museum, Department of Physiological Zoology and Department of Genetics, University of Helsinki, Helsinki, Finland

HACKMAN, W., LAKOVAARA, S., SAURA, A., SORSA, M. & VEPSÄLÄINEN, K. 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.

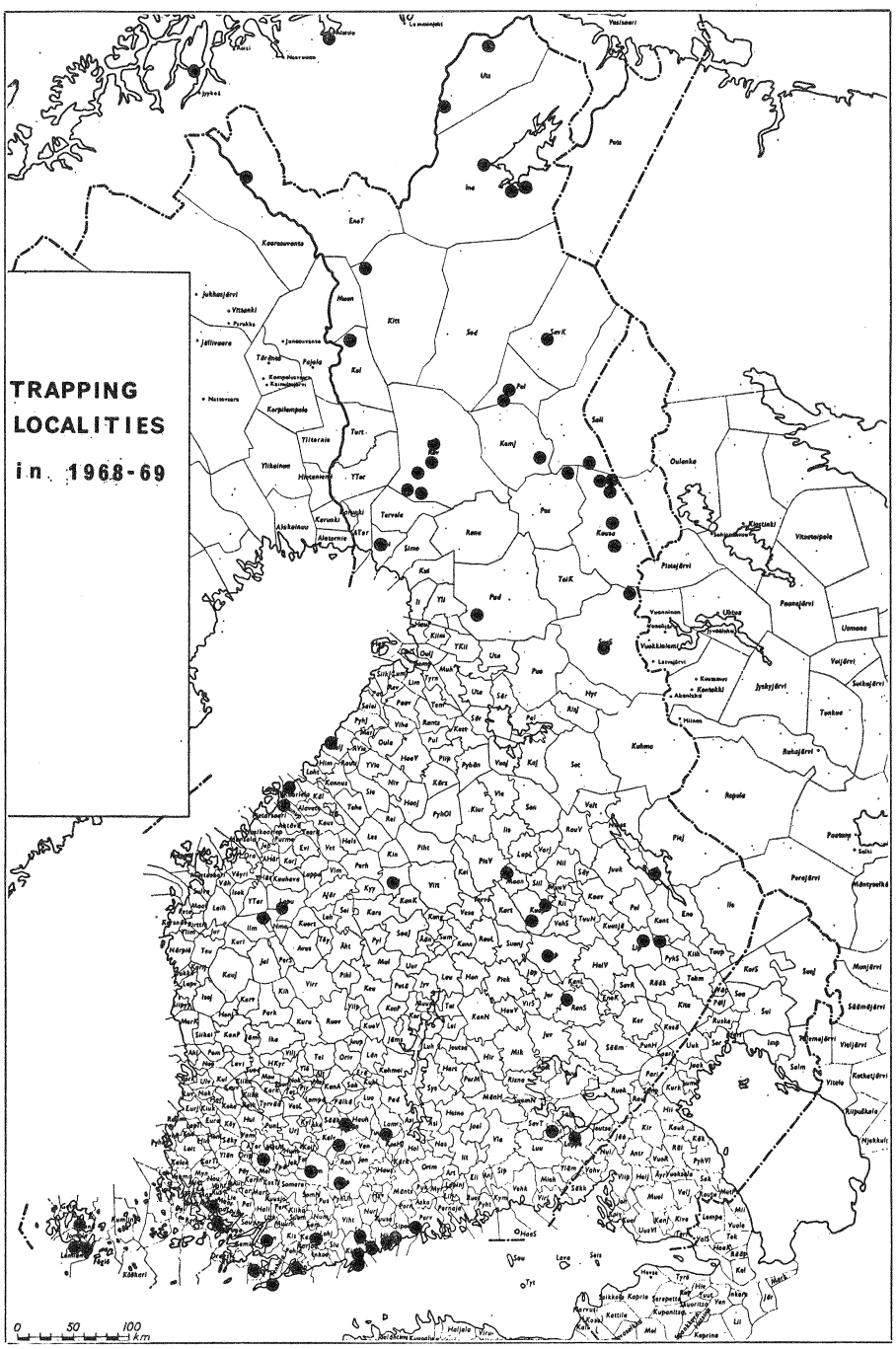
A taxonomic key to the European *Chymomyza* species is presented, based on material collected from Finland. The distribution of the species is elucidated with special reference to Finland. The rearing, third instar larval diapause in populations derived from certain areas, successive stages of development and karyotype (2n = 8) of *Chymomyza costata* are described. The taxonomic position of the genus *Chymomyza* is also discussed.

This study is based mainly on the Drosophilids trapped in 1968 and 1969 with malt baits (LAKOVAARA, HACKMAN & VEPSÄLÄINEN 1969) on various biotopes in different parts of Finland (Map 1). The material (about 19000 specimens) comprises 32 of the 45 species occurring in Finland, including all the known European *Chymomyza* species, namely *C. costata* Zetterstedt, *C. caudatula* Oldenberg, *C. distincta* Egger and *C. fuscimana* Zetterstedt. In addition, some older data on localities were included.

The study was chiefly concerned with *C. costata*, the most common *Chymomyza* species in Finland. It is represented in the material by about 2000 specimens and laboratory cultures from 17 different populations have been established.

Key to the European species

1. Frons dark grey, at most slightly paler in front. Mesonotum at least medially dull grey. Costa never milky white near apex 2
– Frons yellow or yellow brown with pale greyish pilosity. Mesonotum mainly yellow brown, at most with narrow grey longitudinal stripes. Costa milky white near apex 3
2. Costa dark and shaded with grey in the costal cell. Fore tarsi entirely dark, in the female nearly black (terminalia Figs. 1, 9) ..... *costata* Zetterstedt
– Costa not shaded. In the fore tarsi the basitarsus is dark but the distal joints are yellow-white (terminalia Figs. 2, 3, 10) ..... *caudatula* Oldenberg
3. In the male genitalia (Fig. 6) the paired strong projection (gonite) of hypandrium has a long, laterally directed bristle submedianly (can usually be seen without dissection). Ovipositor guide of the female with a long bristle in the middle of the ventral margin (Fig. 12) ..... *distincta* Egger
– No long lateral submedian bristle on the strong hypandrial gonite (Figs. 4 and 5). Ovipositor guide with its longest marginal bristles in the apical third (Fig.11) ..... *fuscimana* Zetterstedt



Map 1.

Some confusion in the nomenclature of *Chymomyza distincta* and *fuscimana* has been cleared up to a certain extent by BASDEN (1961). *C. distincta* Egger is the species thought to be *fuscimana* by OLDENBERG (1914) and DUDA (1935). *C. fuscimana* Zetterstedt is the species for which various authors (e.g. DUDA 1935 and OKADA 1956) have used the name *nigrimana*

Meigen and which OLDENBERG (1914) interpreted as *distincta*. The true identity of Meigen's *nigrimana* is, according to BASDEN (1961), uncertain and not used here for either of the two close species. *C. distincta* and *fuscimana* are extremely similar, except for the characters of the terminalia.

Chymomyza costata (Zetterstedt 1838)

Distribution. *C. costata* is the most common species of the genus in Finland. It is known from all the biological provinces (except EK), probably occurring in all parts of the country. It is more common in the north than in the south, being by far the most common Drosophilid species in Lapland (Map 2). *C. costata* is also known from other parts of Northern Europe, Central and Western Europe, western Russia, Hungary and Japan (Honshu, OKADA 1956).

Bionomy. *Chymomyza costata* is easy to rear in the laboratory on a malt culture medium (LAKOVAARA 1969). In southern Finland the species appears to be multivoltine and in the Lappish interior strictly univoltine, almost all larvae going into diapause at the end of the third larval instar. In central Finland mixed populations are found, which include both uni- and multivoltine strains. The following tabulation shows the correlation between voltinism and northern origin in our laboratory stocks of *C. costata* collected in Eastern Fennoscandia in 1968 and 1969.

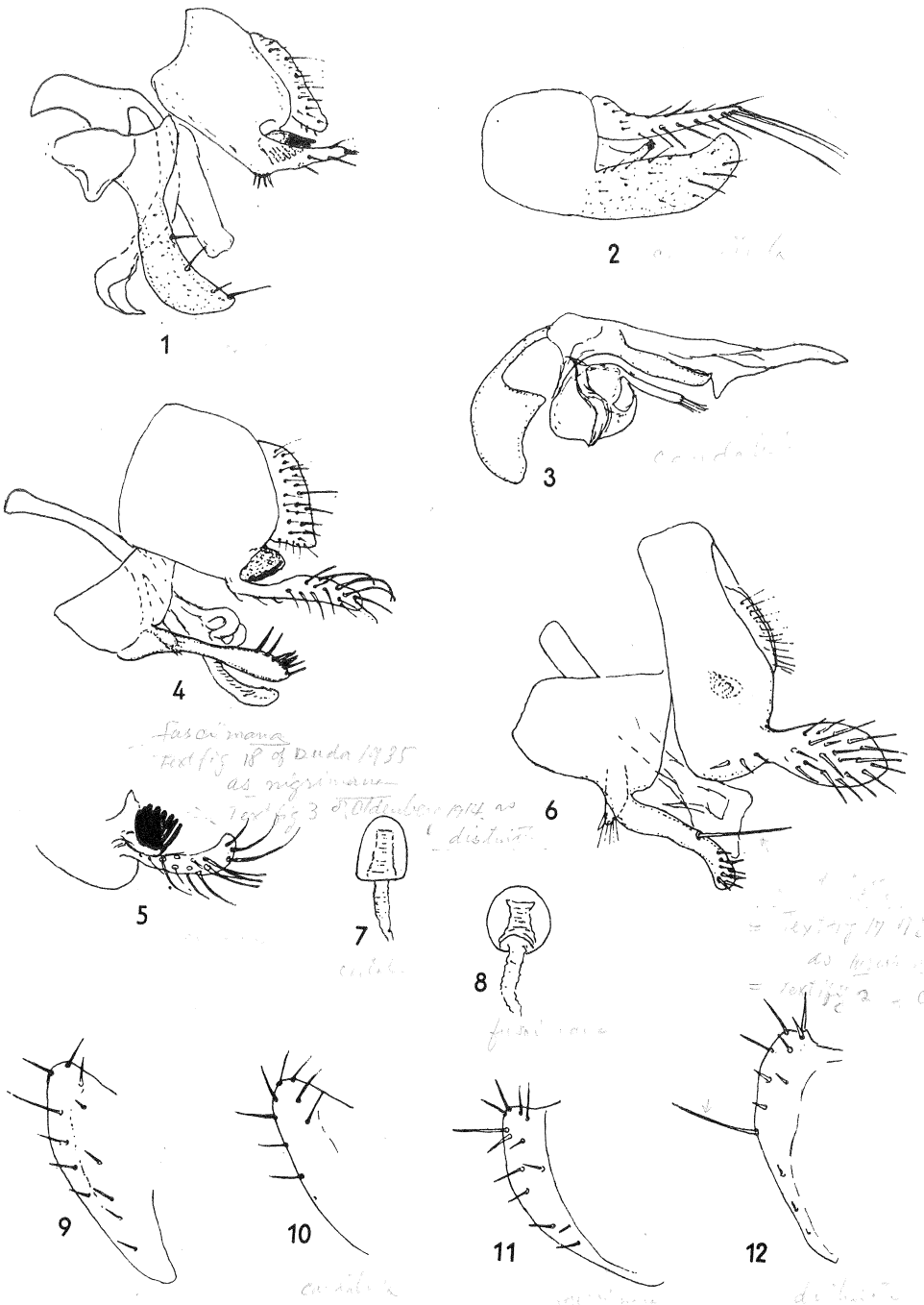
latitude of origin	multi-voltine	mixed	uni-voltine	total
60°	3			3
63°	1	1		2
65 – 66°		1	2	3
66 – 70°		1	8	9

It may be mentioned that the only northern (66 – 70°) population with both uni- and multivoltine elements originates from the Arctic coast of Norway (Alta), where the climate is milder than in the interior of Lapland. As shown in Map 3, temperature seems to be the factor influencing voltinism in *C. costata*. Under laboratory conditions the larval diapause can be broken by cold treatment for about two months at + 2° C.

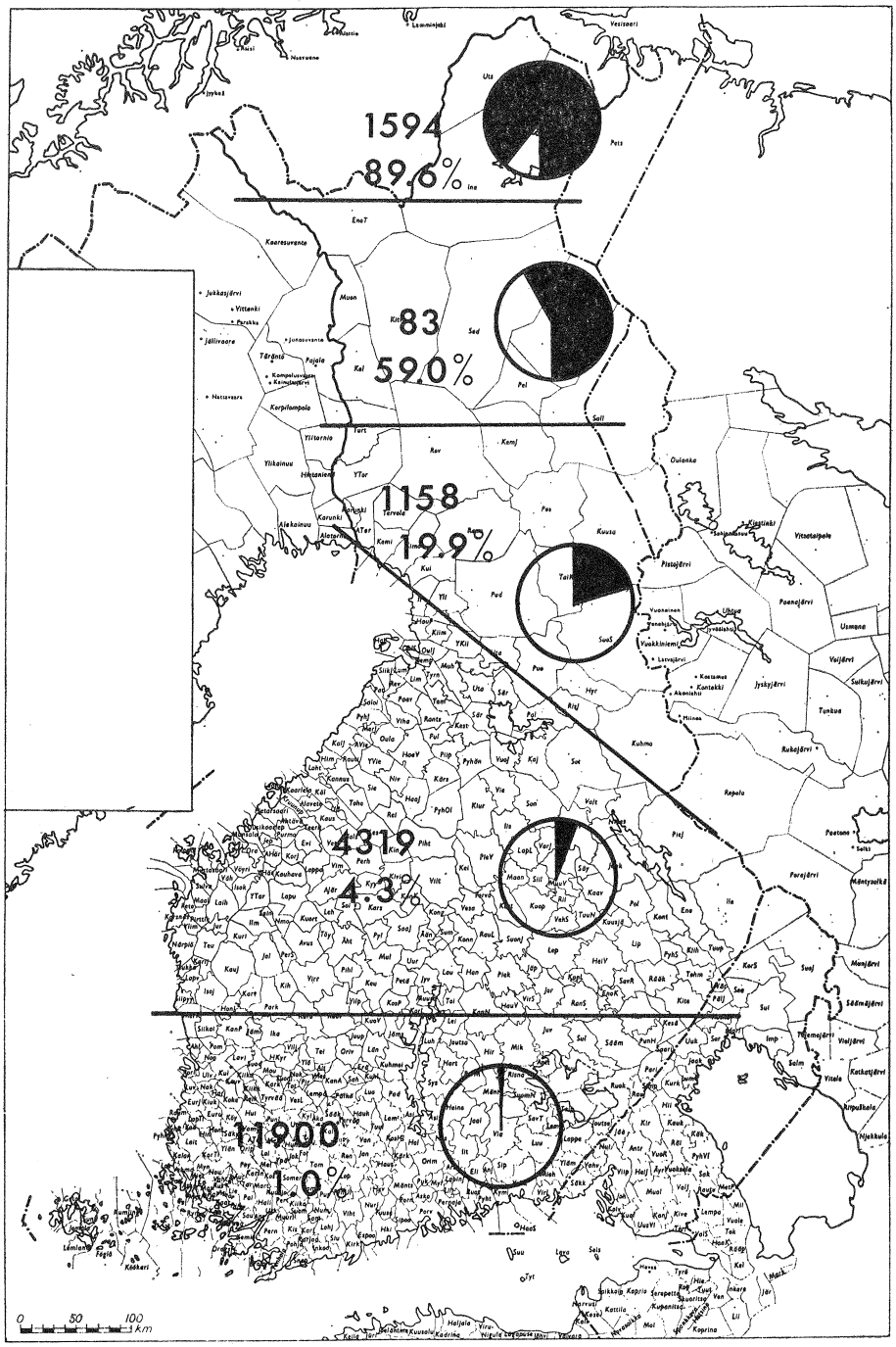
The earlier instars of *C. costata* have not been figured before. The egg has 8 filaments (Fig. 17). The larval mouth hooks (Figs. 13, 14 and 15) are without dentition in all three instars. The latticed process is fused to the dorsal wing of the pharyngeal sclerite in the third-instar larva (Fig. 15). The anterior spiracle of the third-instar larva has short branches of almost equal length (Fig. 16). This organ is of similar shape in the puparium and does not differ much from that of *C. caudatula* (OKADA 1968). The puparium in *costata* is about as elongate as in *caudatula* but differs in surface structure. In *costata* there are at most one row of dorsal hooklets on each abdominal segment as compared with 8 in *caudatula*. On the ventral surface there are bands with about six rows of hooklets on the segments, whereas there are eight rows in *caudatula*. The caudal part of the puparium is shown in Figs. 18 and 19.

Chromosomal characteristics. Preparations made of ganglion cells of third-instar larvae revealed the chromosome number of *C. costata* to be 2n = 8. In morphological respects also, the mitotic chromosomes resemble the karyotype of *Drosophila melanogaster*, thus belonging to the »Type A» of METZ & MOSES (1923). The metaphase plate consists of two pairs of long metacentric and one pair of dotlike autosomes, while the sex chromosome pair comprises an acrocentric X chromosome and a submetacentric Y chromosome (Figs. 20 and 21). The latter behaves heteropycnotically during interphase.

On the other hand, the appearance of the salivary chromosomes is unlike *D. melanogaster*. In most of the salivary gland cells the degree of polyteny in the giant chromosomes is obviously rather low, as estimated from their diameter. Asynapsis of the homologues is frequent as well as ectopic pairing between nonhomologous chromosome regions. In addition, the



Figs. 1 – 12. — 1. *Chymomyza costata* Zett., male genitalia in side view. — 2 – 3. *C. caudatula* Oldenb. male genitalia, dorsal parts in side view (2), ventral parts (hypandrium and phallic organ) (3). — 4 – 5. *C. fuscimana* Zett., male genitalia, in side view (4) and epandrial projection and surstylus in ventral aspect (5). — 6. *C. distincta* Egger, male genitalia in side view. — 7 – 8. Spermathecae of *C. costata* (7) and *fuscimana* (8). — 9 – 12. Ovipositor guides of *C. costata* (9), *caudatula* (10), *fuscimana* (11) and *distincta* (12). — Orig.



Map 2. The frequency of *Chymomyza costata* in the Drosophilid samples trapped in 1968 – 1969. The number in each locality indicates the total number of Drosophilids caught, the black area in a circle and percentage the proportion of *C. costata* in the sample.

polytene chromosomes seem very apt to break during preparation. Consequently, the banding pattern of the polytene chromosomes is not easy to work out by ordinary methods. Large nu-

cleoli, with an average diameter of 12 µ, are observable in the salivary gland nuclei.

The other Chymomyza species

C. caudatula OLDENBERG 1914

A rare but widely distributed species: U: Espoo, Kolmperä June 16, 1968, 1 ♂ (W. Hackman); PS: Kuopio, Vaajasalo July 3, 1968, 1 ♂ (S. Lakovaara); Ks: Oulanka July 14, 1968, 1 ♂ (K. Vepsäläinen); June 30, 1969, 1 ♂ (S. Lakovaara); PP: Rovaniemi, Valajaskoski June 25, 1969, 1 ♀ (S. Lakovaara).

The species is new to Northern Europe. Previous European records are from Austria, Hungary (type locality Herculesbad) and Rumania (BASDEN 1961). Further from Japan: Hokkaido (OKADA 1956) and U.S.A.: Alaska, Washington to Wyoming, south to California and Arizona, Michigan to Maine (WHEELER 1965).

Bionomy: see OKADA (1968).

C. distincta (EGGER 1862)

All known Finnish records are V: Lohja, 1 ♂ (R. Frey), Vihti, 4 ♀ (R. Tuomikoski); U: Espoo, Kolmperä June 19 – 20, 1968 2 ♀♀; August 6, 1968 1 ♀; August 16, 1969 2 ♀♀; August 19, 1969 1 ♀ (W. Hackman); Helsinki 1 ♂, 1 ♀ (R. Frey); EH: Sääksmäki August 27 – 28, 1934 (E. Kivirikko); Kangasala, 1 ♀ (R. Frey); PS: Leppävirta June 18, 1969 1 ♀ (A. Nederström); KP: Pietarsaari August 18, 1958 1 ♂ (R. Storå).

Known from Germany (Glatz, Schwarzwald and Berlin, *fuscimana* of DUDA 1935) and Austria (Egger's type specimen, see BASDEN 1956).

Bionomy unknown.

C. fuscimana (ZETTERSTEDT 1838)

Like the preceding species rarely trapped on fermented baits. Known Finnish records: V: Kuusisto 1 ♀ (C. Lundström); Lohja August 19 – 20, 1932 5 ♂♂ (R. Krogerus); Vihti 3 ♂♂ (R. Frey); U: Helsinki 10 ♂♂ (R. Frey); Helsingin mlk. Linna 1 ♂ (R. Frey); St: Kokemäki June 1953 2 ♂♂, 2 ♀♀ (R. Tuomikoski); EH: Loppi August 27, 1934 (K. Ahnger); Messukylä 1 ♀ (R. Frey); Sääksmäki August 27 – 28, 1934, 3 ♀♀ (E. Kivirikko); Kangasala 1 ♀ (R. Frey); PH: Laukaa 1 ♀ (F. Woldstedt); PS: Kuopio, Kurkimäki August 13 – 16, 1969 1 ♂, 1 ♀ (S. Lakovaara); KP: Pietarsaari, Varvet August 7, 1952 1 ♀; July 30, 1955 1 ♀; July 9, 1956 1 ♀; August 17, 1958 1 ♂, 1 ♀; August 18 – 19, 1958 1 ♂, 1 ♀; August 7, 1959 1 ♂; July 20, 1968 2 ♀♀; August 11, 1968 1 ♀, August 26, 1969 1 ♀; Uusikaarlepyy September 9, 1955 1 ♀ (R. Storå); Ks: Oulanka July 17, 1968 1 ♀ (K. Vepsäläinen); InL: Inari July 16, 1969 1 ♀ (P. Nuorteva).

From adjacent parts of USSR: Kk: Pyhäjärvi 1 ♀, (J. Sahlberg); LK: Salmi 1 ♂ (R. Tuomikoski); PK: Suojärvi 1 ♂ (R. Tuomikoski).

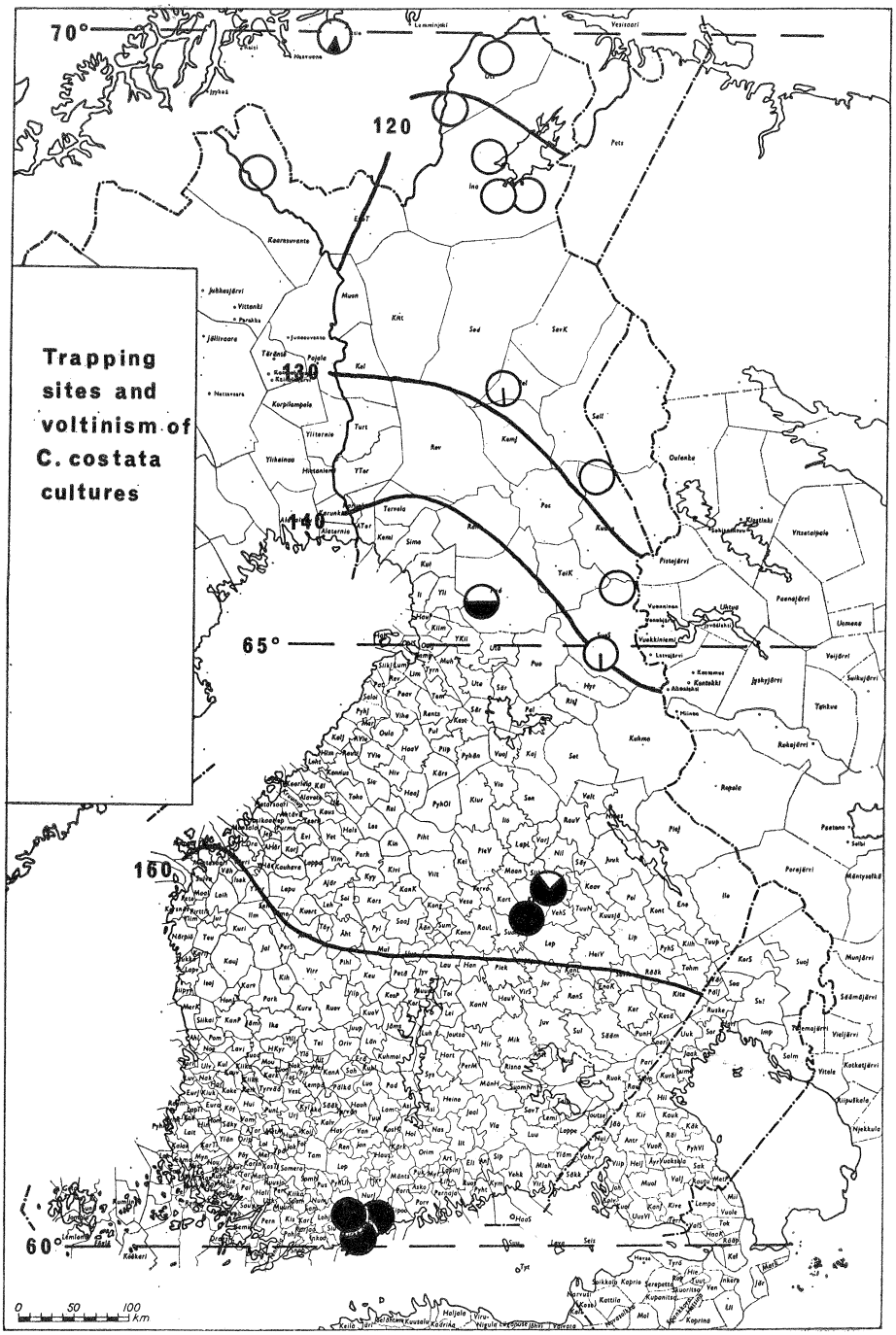
In Finland, as elsewhere in Europe, *C. fuscimana* is more common and more widely distributed than *distincta*. In Sweden, Central Europe, the Leningrad area, the British Isles (*nigrimana* and *distincta* of various authors), Siberia (*albopunctata* Becker from Nikandrev Island, type checked by the author HACKMAN), Japan (*nigrimana* of OKADA 1956).

Earlier instars unknown. BASDEN (1954) found imagines on birch sap. Frequently observed on timber piles.

Taxonomic position of the genus Chymomyza

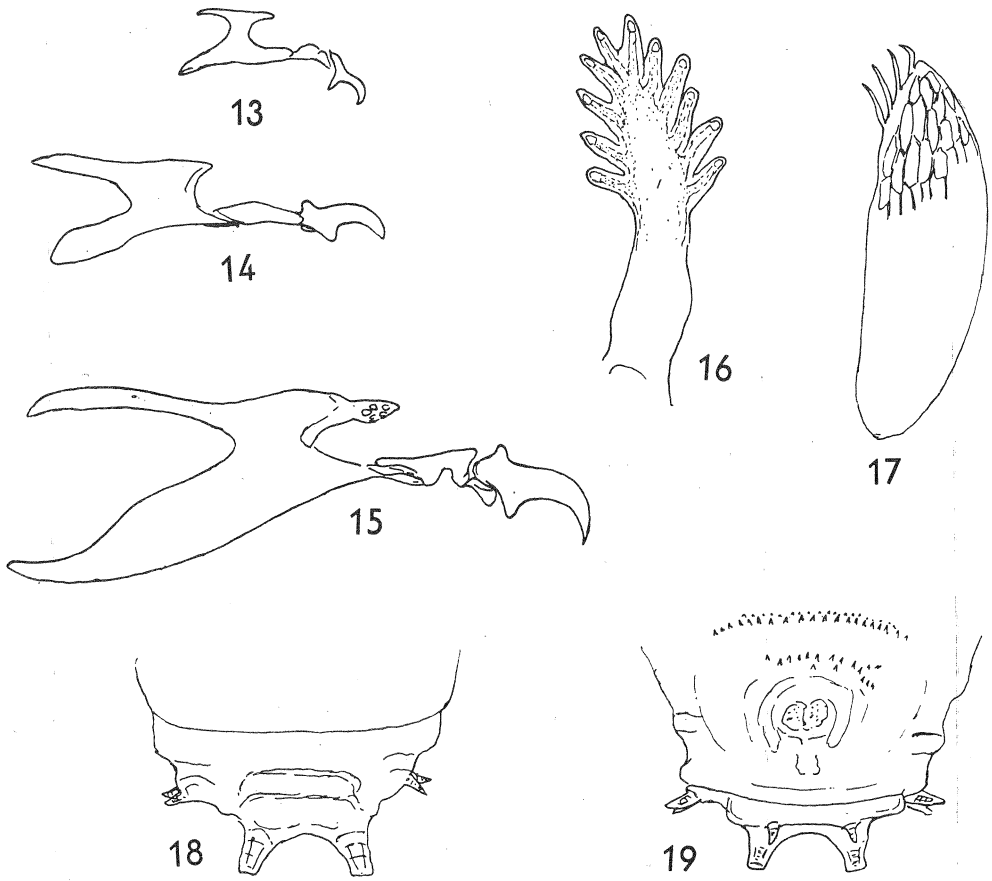
In his papers on the phylogeny of the genera, subgenera and species groups of the *Drosophila* complex, THROCKMORTON (1962, 1965) has derived *Chymomyza* from the *Sophophora* branch. Several taxons (*Mycodrosophila, Scaptomyza, Leucophenga, Microdrosophila* and others), hitherto considered to be genera, are derived from various points in THROCKMORTON's phylogenetic tree of *Drosophila* (THROCKMORTON 1965) and thus the genus *Drosophila* is paraphyletic in HENNIG's (1965) sense.

In respect of chaetotaxy and genital characters, *Chymomyza* can be considered a clear-cut taxon and ranked as a genus. However, its systematic position seems to have links in two directions. The larval morphology shows affinities with the subgenus *Scaptodrosophila* in *Drosophila* (cf. OKADA 1968), while some characters of internal anatomy (testes and paragonia, ejaculatory bulbs and apodemes, cf. THROCKMORTON 1962) suggest affinity with the subgenus *Sophophora* in *Drosophila*. Although, in the evaluation of the taxonomic position of species in the *Drosophila* complex, the use of purely karyological characters might be dangerously



Map 3. The black area within each circle (trapping site) represents the proportion of multivoltine and the white area that of univoltine individuals in the F_1 generation offspring of *C. costata* stocks caught in the wild. The curves show the duration (in days) of the thermal summer (temperature $\geqq 5°$ C).

biased, a consideration of the chromosomal characteristics as a supplement to the taxonomically important characters of morphology and anatomy is often informative. Apparently



Figs. 13 – 19. — 13 – 15. *C. costata,* larval pharyngeal skeleton, first instar (13), second instar (14) and third instar (15). — 16. *C. costata,* anterior spiracle of the third instar larva. — 17. *C. costata,* egg (surface structure drawn only in part). — 18 – 19. *C. costata,* caudal part of puparium, from above (18) and from below (19). — Orig.

only three species of the genus *Chymomyza* have hitherto been studied cytologically, namely *C. amoena* Loew, *C. procnemis* Williston (Metz & Moses 1923) and *C. costata.* In all these three species the basic chromosome pattern is the same, characterized as »Type A» (Metz & Moses). As regards the systematic position of the taxon *Chymomyza,* this information, although still too scanty, weighs the balance in favour of the *Sophophora* branch. The best solution would perhaps be to insert the genus as a branch of its own between *Scaptodrosophila* and *Sophophora.*

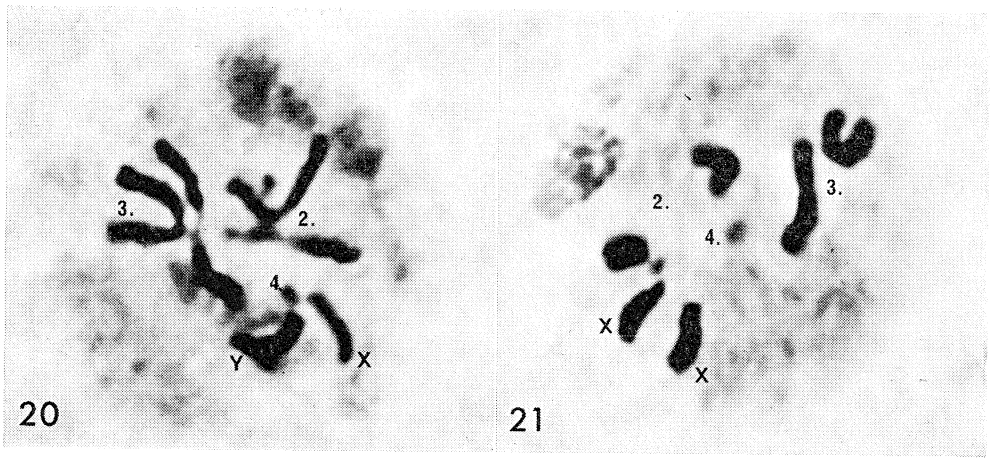
Acknowledgements: We are indebted to the following persons who have aided in collecting material for this study: Professor Esko Suomalainen, Dr. Pekka Nuorteva, Ragnar Storå, M.Sc., Juhani Lokki, M.Sc., Antero Nederström, B.A., Mrs. Aili Lappalainen, Miss Sirkka Hokajärvi and Mr. Jorma Immonen. Mrs. Jean Margaret Perttunen has kindly checked the language. This study has been supported by grants from the National Research Council for Sciences and Societas Scientiarum Fennica.

References

Basden, E. B. 1954. The distribution and biology of Drosophilidae (Diptera) in Scotland, including a new species of »Drosophila». — Trans. R. Soc. Edinburgh 62, 603 – 654.

— 1956. Drosophilidae (Diptera) within the Arctic Circle. I. General Survey. — Trans. R. Ent. Soc. London 108, 1 – 20.

— 1961. Type collections of Drosophilidae (Diptera).



Figs. 20 – 21. Metaphase chromosome plates from larval ganglion cells of *Chymomyza costata* male (20) and female (21). Magn. × 5500. — Orig.

1. The Strobl Collection. — Beitr. Ent. 11, 160 – 224.

DUDA, O. 1935. Drosophilidae in LINDNER: Die Fliegen der Palearktischen Region. VI (58 g), p. 1 – 118.

HENNIG, W. 1965. Phylogenetic systematics. — Ann. Rev. Ent. 10, 97 – 116.

LAKOVAARA, S. 1969. Malt as a culture medium for Drosophila species. — Drosophila Inform. Serv. 44, 128.

LAKOVAARA, S., HACKMAN, W. & VEPSÄLÄINEN, K. 1969. A malt bait in trapping Drosophilids. — Drosophila Inform. Serv. 44, 123.

METZ, C. W. & MOSES, M. S. 1923. Chromosomes of Drosophila. Chromosome relationships and genetic behaviour in the genus Drosophila: I. A comparison of the chromosomes of different species of Drosophila. — J. Heredity 14, 195 – 204.

OKADA, T. 1956. Systematic study of Drosophilidae and allied families of Japan. — 183 pp. Tokyo.

— 1968. Systematic study of the early stages of Drosophilidae. — 188 pp. Tokyo.

OLDENBERG, L. 1914. Beitrag zur Kenntnis der europäischen Drosophiliden (Dipt.). — Archiv. Naturg. 80 A (2), 1 – 42.

THROCKMORTON, L. H. 1962. The problem of phylogeny in the genus Drosophila. Studies in Genetics II. — Univ. Texas Publ. 6205, 207 – 343.

— 1965. Similarity versus relationship in Drosophila. — Syst. Zool. 14, 221 – 236.

WHEELER, R. M. 1965. Family Drosophilidae. — In STONE et al. A catalog of the Diptera of America North of Mexico, 734 – 772.

Received 1. XII. 1969