

An English translation of:

"Zur Cytotaxonomie nordamerikanischer Chironomus-Arten"  
by Wolfgang Wülker, James E. Sublette and Jon Martin.  
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During the First International Chironomid Symposium, STEFFAN (1966) has fully presented the more important aspects of the earlier cytotaxonomic investigations of chironomids. KEYL especially (1959, 1960, 1961, 1962) has proved methods within the genus Chironomus, which like all others, have certain advantages but also difficulties and limitations of their application.

They are based on the investigation of giant chromosomes and use thereby a "primary" species characteristic which is not directly influenced environmentally. In many cases it has proved more efficient than the classical morphological methods, when for example clear chromosomal differences were found in cases in which the external differences of adults, pupae and larvae were greatly inferior, and difficult to discern because of high individual variability. Beyond these advantages for the systematist, the cytotaxonomic analysis is able to derive the phylogenetic relationships of the Chironomus species (KEYL 1962).

Nevertheless the cytotaxonomic method has been regarded in many places as hard to use. Undoubtedly there exists also-when one has removed the easily overcome problem of preparation - in species with high intraspecific inversion polymorphism, difficulty in the correct valuation of the results, and the poor chromosome structure of some species place limits on the analysis. However the arguments against it are weak as compared with the results obtained so far. Therefore the further use of the method appears to be very desirable.

Naturally the cytotaxonomy is no cure all for the many things ailing chironomid systematics. It is - as already said by STEFFAN - "It is generally no better classification indicator than other morphological characters" and would by itself alone certainly be insufficient aid to the taxonomy of chironomids. Considering these facts STRENZKE and KEYL did a combined experiment to reach an equally weighted morphological and cytological revision of the genus Chironomus. However this work remains incomplete due to the sudden death of STRENZKE, and is confined to the area of West Germany.

This was one of the reasons that a group of workers has been formed, with its centre in the Eastern New Mexico University in Portales/ New Mexico, with the set aim of examining the North American chironomid fauna- again proceeding from the genus Chironomus - investigating comparative morphology, cytotaxonomy and haemolymph electrophoresis and to compare with the European (species).

For about 130 chironomid species a holarctic distribution is listed, without any certainty that the equating of the discoveries from both continents is correct. There is a suspicion that many of these "species" are in actuality closely related species pairs, having developed from a common ancestry since the isolation of the populations of both continents. Likewise, when one actually deals with a truly holarctic species it must be borne in mind that, because of the isolation in the populations of both continents they may have developed different patterns and different frequencies of intraspecific rearrangements, as has already been described in the work of ACTON (1958 ff) on Ch. tentans and BASRUR (1957) on Glyptotendipes barbipes.

The composition of the work group also offered the opportunity to include the Australian fauna in the comparison.

The chromosomes of the North American chironomid species have been dealt with so far only in a very few works and mostly only in relation to the intraspecific inversion polymorphism.

ROTHFELS & FAIRLIE (1957) have described the inversion polymorphism of Ch. attenuatus (syn. Ch. decorus) and compared (it) with the existing published observations on Ch. luridus, Ch. tentans, Ch. pallidivittatus and Glyptotendipes barbipes.

BASRUR (1957) investigated the inversion pattern in Canadian and German material of Glyptotendipes barbipes and found not only common, but also continent specific changes of the standard sequence.

ACTON (1958, 1959, 1962, 1965) found differences between Canadian and European populations of Ch. tentans, in chromosome 2 reaching the rank of species differences, however in other chromosomes these differences are less significant. Also in this species there is not only the same inversion pattern in both continents, but also specific "Canadian" and specific "European" rearrangements.

REMPEL, NAYLOR, ROTHFELS, & OTTONEN (1962) have endeavoured to ascertain the genetic sex of parasitic intersex individuals by using the chromosomes of the insufficiently described "species" Ch. rempeli Thien., which differs from European anthracinus populations by a sex linked inversion in arm F.

BLAYLOCK (1963, 1965, 1966), finally, compared a species described as Ch. tentans in detail with the results of other authors. It appears from the published photographs and some original preparations lent to us that the studied species was not Ch. tentans. The combination of the chromosome arms is AB,CD,EF,G (thummi-group), not AB,CF,DE,G as in Camptochironomus.

The basis of the comparison of European Chironomus species by KEYL was the fact that the studied species of the genus, at least in the three long chromosomes, possess similar, i.e. homologous bands, distributed in 6 equally homologous arms (A-F). Certain structural modifications (different proportional relationships of the chromosomes, heterochromatinization in the centromere region and differences of homologous intercalary structures) occur, but mostly don't stand in the way of comparing homology. The most important species differences consist of different combinations of whole chromosome arms, transpositions of short chromosome segments and a great number of inversions.

First was to prove whether the pattern of homologous bands in Germany, which is not valid without exception, also occurred in other continents. At least 16 North American and 9 Australian \* species have the homologous arms A-G, observed in Europe, readily recognisable. One species however, the wide-spread North American Ch. attenuatus, shows similar marked cytological divergence like the European Ch. salinarius, which KEYL (1962) himself could not co-ordinate in his system, and he therefore viewed the latter as systematically distant. In both cases only arm E and the groups 2-9 in arm F appear able to be compared with certainty with other Chironomus species, whereas both species are morphologically considered to belong clearly in the genus Chironomus s. str. The reason and the systematic significance of such divergence between morphological and cytotaxonomic differences is still unknown. The suggestive thought that these cytologically aberrant Chironomus species represent the transition to other genera or subgenera and the identifiable groups are "Landmarks" to the recognition of supra-specific taxa, as is true in the example of the simuliids (ROTHFELS & DUNBAR 1953, DUNBAR 1966), cannot as yet be followed up because the chromosome pattern of other chironomid genera is not yet known in detail.

KEYL (1962) has divided the genus Chironomus into five groups recognisable by different whole arm combinations. A simple table (Table 1)

\* 8 AUSTRALIAN AND 1 NEW ZEALAND

TABLE 1. Possible and actually observed combinations of chromosome arms. Types identified by KEYL (1962) are underlined, our own observations are shown by a dotted line.

<u>AB</u>	<u>AB</u>	<u>CD</u>	<u>EF</u>	<u>thummi-group</u>
<u>AC</u>	<u>AB</u>	<u>CE</u>	<u>DF</u>	
<u>AD</u>	<u>AB</u>	<u>CF</u>	<u>DE</u>	<u>Camptochironomus</u>
<u>AE</u>	<u>AC</u>	<u>BD</u>	<u>EF</u>	
<u>AE</u>	<u>AC</u>	<u>BE</u>	<u>DF</u>	
<u>BC</u>	<u>AC</u>	<u>BF</u>	<u>DE</u>	<u>parathummi</u>
<u>BD</u>	<u>AD</u>	<u>BC</u>	<u>EF</u>	<u>commutatus</u>
<u>BE</u>	<u>AD</u>	<u>BE</u>	<u>CF</u>	
<u>BF</u>	<u>AD</u>	<u>BF</u>	<u>CE</u>	
<u>CD</u>	<u>AE</u>	<u>BC</u>	<u>DF</u>	
<u>CE</u>	<u>AE</u>	<u>BD</u>	<u>CF</u>	
<u>CF</u>	<u>AE</u>	<u>BF</u>	<u>CD</u>	<u>pseudothummi-group</u>
<u>DE</u>	<u>AF</u>	<u>BD</u>	<u>CE</u>	
<u>DF</u>	<u>AF</u>	<u>BC</u>	<u>DE</u>	
<u>EF</u>	<u>AF</u>	<u>BE</u>	<u>CD</u>	New type

shows that not only for the combination of two chromosome arms, but also for the combination of six arms in a chromosome set, only a part of the listed possibilities has been described so far. Moreover, as far as we know at present the different translocation types are represented to different extents. In the North American fauna it appears that, as in Europe, the combinations AB,CD,EF,G (thummi-group) and AE,BF,CD,G (pseudothummi-group) predominate, the 9 \* closely studied Australian species belong exclusively to the pseudothummi - type. The parathummi and commutatus types, each represented in Germany by a single species have, in our extensive analysis, traversing the whole nearctic, not yet been found, on the other hand there is an obviously widely distributed (California, Ontario) unknown sixth translocation type AF,BE,CD,G, whose bearers have not yet been specifically identified.

Although the existing knowledge naturally gives only a limited segment of the totality of the existing Chironomus species and always depends on the completion, it appears nevertheless that specific translocations - on account of fertility differences, differential selective value or other conditions of life - have developed or have been maintained preferentially during the evolution of Chironomus species, and that the distribution picture of different translocation types in the different continents is by no means the same.

The preference for specific whole arm combinations occurs also in the analysis of Chironomus species with lower chromosome numbers. In the case of the single previously observed Chironomus species with 3 chromosomes, the European Ch. commutatus, the acrocentric arm G is translocated onto arm E of the metacentric chromosome FE. The rest of the chromosome arms have the combination AD,BC, not known from other species, derived from the thummi group by a reciprocal translocation. The same combination FEG is found in three American Chironomus species with 3 chromosomes, (Ch. staegeri, Ch. crassicaudatus and an unidentified species from Oklahoma), however these species belong directly in the thummi-group (AB,CD,FEG). Also in an Australian species (Ch. occidentalis), E is combined with G; since this species belongs however to the pseudothummi-group, the combination is BF,CD,AEG. Great interest in this connection is demanded by a Chironomus species with 2 chromosomes found in Wisconsin and Ontario. Up to this point this situation has been observed only once in Cryptochironomus of the defectus group (Bauer 1945), without its occurrence having been explained. The analysis of the American species, belonging to a cytologically well known genus will perhaps advance. However it is not yet completed.

Also the inversion pattern of the North American Chironomus species differs substantially from the European (species). To be sure we found, for example, the inversion 17-11 in arm F in Europe typical of Ch. aberratus, also in many American species, likewise the inversion 12-4/10-2d (Ch. holomelas) and the thereon based 4d-2g/13b-12b (in plumosus II) in arm A and the inversion 10b-3f (Ch. halophilus among others) and 5-10b (Ch. cingulatus among others) in arm E. Connecting with these configurations or isolated from them, there are however numerous types of linear structural alteration not yet known in Europe, which accentuate the uniqueness of the American species, whose individual description however shall be



kept for a special investigation.

The differences of both faunas is also brought out by the fact that the original intent, to examine the holarctic distribution of certain chironomid species and to confirm it is possible, was successful for only three well known and abundant Chironomus species in Europe, namely Ch. plumosus, Ch. anthracinus and Ch. tentans; but a fourth (example) may be added by at least one species of the likewise very common, insufficiently described riparius-thummi species complex. All other Chironomus species are, according to existing knowledge, different which is not surprising considering the separation of the continents dates at least since the glacial period. Whether in this case the present boundary is the Bering Strait or - as ACTON plausibly claimed for Ch. tentans - lies in south Alaska, and whether the same is true for other chironomid genera, must be clarified by future research.

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