

Flies (*Diptera*) of the saline habitats of Poland

Muchówki (*Diptera*) zasolonych siedlisk Polski

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ABSTRACT. Flies were investigated in all main types of the Polish saline habitats (in 12 localities) and 516 species from 55 families are found; 63 of them are halobionts and halophils. Four ecological categories are recognized for them: marine halobionts, inland halobionts, halophils and haloxenes. Species composition is presented for inland saline, coastal, and marine habitats, including numeric ratios of individual species. Recorded from Poland for the first time are 62 species (including 21 halobionts and halophils). Eleven zoogeographic elements are found among the Polish halophilic and halobiontic *Diptera*. Ecology of these species is discussed. New data are given on the Polish *Tethinidae*, and *Pelomyia coronata* is redescribed.

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Szadziewski, 1983

INTRODUCTION

Organisms occurring in saline habitats are usually divided into halobionts, halophils and haloxenes depending on their relationship with the salinity.

Halobionts develop only in saline habitats. Two types of halobionts can be distinguished: thalassohalobionts or marine halobionts (H_m) which cover marine life, and inland halobionts (H_b) which require inland ecological conditions (the latter occur in marine, coastal and inland saline habitats). The broad treatment of the latter group allows the inclusion not only of aquatic halobionts usually described as brackish (hyphalmyrobs of REMANE; REMANE and SCHLIEPER, 1971) but semiaquatic and terrestrial ones as well. This group comprises inland halobionts, obligatory mesobionts associated with halophytes and most of the marine halobionts distinguished by KARL (1930).

Halophils (H_{ph}) comprise oligotopic species which are found more often and more numerous in saline habitats than in non-saline habitats. Most often they are holocuryhalinic, i.e., they occur in a wide range of habitats from non-saline up to hyperhalinic. The quantity criterion which is often used to define halophils is of little value because ecological factors other than salinity also play an important role, for instance, the size of salt water areas, oxygen content, type of soil, food sources, etc. KARL (1930), REMMERT (1955), BEŠOVSKI (1975) and others included here polytopic species which can successfully enter saline habitats. According to these authors, halophils include, for example, *Lathyrphthalmus acneus* and *Eristalis arbustorum*, whose larvae inhabit even cloacal pits.

Haloxenes (H_x) occur more often and more numerous in specific non-saline habitats than in saline ones. This ecological group is composed of the species which during their life history are in direct or indirect contact with saline habitats as well as species having no contact. Although the latter species are completely indifferent to salinity, most of them are stable components of the fauna of inland saline and coastal areas, for example, the predaceous *Syrphidae* whose larvae do not leave plants even for pupation. To this group also belong completely accidental species flying in search of flowers or prey or being carried by the wind.

One may consider as halobionts mono- and oligophagous gall-making and mining flies on the obligatory halophytes, but as haloxenes oligo- and polyphages both on obligatory and haloxenic halophytes, and also all phytophages on facultative halophytes.

The halophilic tendency occurs in many groups of aquatic, semiaquatic

and terrestrial flies. Three families of Polish *Cyclorrhapha* are exclusively halobiontic, i.e., *Helcomyzidae*, *Coelopidae* and *Tethinidae*. The former two families are represented by marine species, the latter one by inland halobionts only. The subfamily *Telmatogetinae* (*Chironomidae*) is exclusively marine, and more than 20 European genera include halobiontic species only. Halobionts occur also in many large genera, most often in groups of related species. There are known sibling halobiont species, for example, *Anopheles labranchiae* FALLERONI and *A. atroparvus* of *A. maculipennis* complex (WHITE, 1978). Halobionts exclusively associated with halophytes do not form groups of related species. They are found solely among the large genera of *Cecidomyiidae*, *Agromyzidae* and *Tephritidae*, except for *Baldratia* KIEFFER and *Halodiplosis* KIEFFER (*Cecidomyiidae*) which include gall-making halobionts associated with *Chenopodiaceae* halophytes.

In Europe there occur about 250 halobiontic and halophilic species of flies from 28 families, mainly *Chironomidae*, *Ceratopogonidae*, *Empididae*, *Dolichopodidae*, *Ephydriidae* and *Muscidae*.

All the main types of saline habitats in Europe are represented in Poland, i.e., the sea, coastal and inland saline areas. Under Polish climatic conditions, only marine and inland mineralized waters are sources of salts and the degree of the water salinity influences the salinity of the saline areas, including surrounding meadows and soils. The salinity of the inland saline areas in Poland is caused by salts from mineral springs and from industrial wastes, for instance of salt mines or soda works. The salinity of the soils fluctuates very rapidly during the year and the results obtained by chemical analysis may be of little value in this respect. For this reason, the best indicators of their salinity are halophytes (WILKOŃ-MICHALSKA, 1962, 1963, 1976).

In Poland extensive brackish (oligo- and mesohalinic) areas of the coastal type are the mouths of the Wisła and Odra rivers, the mesohalinic Bay of Puck and the oligohalinic lakes of the central Coast of Poland. The detailed distribution of the coastal brackish marshes and meadows surrounding the brackish reservoirs is given by PIOTROWSKA (1966, 1974, 1976). Inland saline areas in Poland are not numerous compared with the west of Europe (BRAUNS, 1959). Most of them occur in the Kujawy region of central Poland (WILKOŃ-MICHALSKA, 1963; LATOUR et al., 1966; KORNAŚ, 1972).

Diptera of saline habitats in Poland have not been studied as a whole, though many valuable papers are available (especially those by KARL, 1922, 1935, 1936, 1937, 1940 who recorded from central coast 30 halobionts and halophils). In the papers published earlier (table 1) 62 halobiontic

and halophilic species of flies have been recorded from Poland (Baltic coast: 49, Kujawy: 20, other regions: 19).

Benthic fauna (no mentioned halophilic species), including *Chironomidae*, have been investigated in the following saline habitats of Poland: mouth of Martwa Wisła (KLEKOT, 1968; KOSZTEYN, 1976), Zalew Wiślany (ŻMUDZIŃSKI, 1957; CYWIŃSKA et al., 1978), Zalew Szczeciński (WIKTOROWIE, 1959) and Jamno Lake (MALEJ, 1974).

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MATERIAL AND METHODS

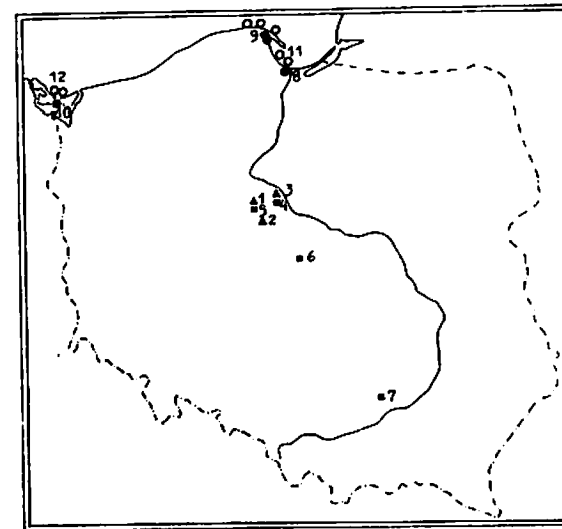
Material for this study was collected from February 1972 to November 1975 and in the summers of 1977 and 1979. Twelve areas, very different in size and representing all types of saline habitats in Poland were investigated (fig. 1). Inland saline areas are represented by seven sites. Three of them are strongly saline, with polyhalinic to hyperhalinic waters. The extensive coastal areas adjacent to the Gulf of Gdańsk (east coast) and around the mouth of the Odra (west coast) were also studied. Beaches facing the open Baltic sea were investigated mainly on the east coast. Except for the above mentioned three stations, all the others are weakly saline with oligo- and mesohalinic waters.

The investigated areas were visited 108 times. Flies were collected mainly by sweeping in halophyte communities near the saline water reservoirs. More than 50 species were bred from waters, soils and plants.

To determine the number of larvae on the inland saline area in Inowrocław-Mątwy, samples of soil covered with *Salicornietum patulae* were taken once a month. Each sample contained ten soil cuttings, 0.7 dm²

and 5 cm deep taken by a metal tube. Larvae were flushed out by drying. Samples of filamentous algae covering the water surface as well as samples of bottom mud and sub-surface water of the saline water reservoirs were taken using a frame covered with a fine mesh net (5 × 0.8 dm²). To determine the approximate number of imagines sweeping samples were taken by 50 or 100 strokes of an entomological net. Similar samples were taken at other sites. Additionally, flies collected at light in Władysławowo and Chałupy on the Bay of Puck and several drag samples taken from the Gulf of Gdańsk were examined.

The content of chloride ions in water was determined according to Mohr's method. The general salinity of waters was calculated using the Knudsen formula, because all investigated waters, including those in inland saline areas, are of "marine" ionic composition type (LATOUR



1. Distribution of the stations

- | | |
|---------------------------------|-------------------------------|
| ▲ — strongly saline inland area | ● — brackish coastal area |
| 1 — Inowrocław-Mątwy | 8 — Gdańsk - Górkki Wschodnie |
| 2 — Janikowo | 9 — Bay of Puck |
| 3 — Ciechocinek | 10 — Karsibór on Uznam island |
| ■ — weakly saline inland area | ○ — brackish marine area |
| 4 — Aleksandrów Kujawski | 11 — east coast |
| 5 — Inowrocław-Rąbin | 12 — west coast |
| 6 — Pelczyska near Ozorków | |
| 7 — Owczary near Busko Zdrój | |

In soil samples from March to November 1975, larvae of *Diptera* represented 99.1% of all arthropods. Among flies, three taxa were particularly common: *Nemotelus* — 67.9%, *Parascatope litorea* — 16.7% and *Dasyhelea* KIEFFER — 13.3%.

In a ten sweeping strokes sample from patches of *Salicornietum patulae* with great numbers of *Triglochin maritimum*, the number of adult *Diptera* averaged from 46.8 in September up to 245.9 in May (on the total of 401.0 and 762.0 arthropods, respectively; fig. 10). The most numerous in these samples were *Ceratopogonidae* (mainly *Dasyhelea* spp.), *Chloropidae* (mainly *Aphanotrigonum cinctellum* and *Thaumatomyia hallandica*), *Ephydriidae* (mainly species of *Psilopa* FALL.), *Dolichopodidae* (mainly *Thinoophilus ruficornis*), *Stratiomyidae* (mainly *Nemotelus notatus*) and *Muscidae* (mainly *Limnospila albifrons* and species of *Coenosia* MEIG.).

Soils covered with *Potentillo-Festucetum arundinaceae* are relatively dry, weakly saline and well-aired, and larvae of *Diptera* were found there down to the depth of 15 cm. In April 1975 only 4,711 larvae per 1 m² were found, i.e., four times less than in soils covered with *Salicornietum patulae* at the same time (18,728). Numbers of imagines in sweeping samples were also much lower during all the season than in the former community. In ten sweeping strokes adult *Diptera* averaged from 19.5 to 66.6 (fig. 10). The most abundant families were *Chironomidae*, *Ceratopogonidae*, *Muscidae* and *Chloropidae*. Only single halobiontic and halophilic flies occurred in this plant community.

Brackish coastal area in Gdańsk - Górkki Wschodnie

As in inland saline areas, flies predominate in the fauna. On the 202 *Diptera* species collected, 32 are halobiontic and halophilic (three of them marine). The rate of the halobiontic and halophilic species (15.9%) is similar to that of the Inowrocław-Mątwy site. However, halobionts and halophils were usually found in smaller numbers on the coast.

Among the 22 *Chironomidae* species occurring here, the most numerous were: *Cricotopus ornatus*, *Paraphaenocladus impensus*, *Chironomus plumosus* and *Parachironomus arcuatus*. On river banks and in pools on meadows there large number of *Aedes caspius* and *A. flavescens* occurred. On the wet, sandy bank of the brackish Ptasi Raj lake *Scatella subguttata* was very numerous in July (an average of 181.3 specimens per ten sweeping strokes; *Diptera* — 216.6; other insects — 3.0). On 1 m² of sand of this bank in September 5,665 larvae of *Diptera* were present, mainly *Duckhousiella ustulata* (3,257) and *Ceratopogonidae* (1,529). In July 1975 in wet places of brackish meadows the flies occurred in greater number than in salt habitats of Inowrocław-Mątwy (125.7). The average number of imagines

per ten sweeping strokes reached 228.2 flies (other insects — 31.6). The most numerous families in the samples were: *Dolichopodidae*, *Empididae*, *Sphaeroceridae*, *Ephydriidae*, *Chloropidae* and *Muscidae*.

Marine habitats of the Baltic Sea

In the brackish marine habitats of the Baltic 88 species of flies were found (83 species in the Gulf of Gdańsk alone); 50 species bred in marine habitats, 38 were accidental. Only 14 halobiontic and halophilic fly species were represented: five marine, four inland halobionts and five halophils. Their rate among the fly species recorded here is 15.9%. *Chironomidae* occurred almost exclusively in the sea littoral. I found only one larva of *Muscidae* dragged out from a colony of *Mytilus edulis* L. at a depth of 5 m. The most numerous marine midge, *Halocladus variabilis*, formed large swarms on the beach during its swarming period in June. At this time up to 528 imagines per ten sweeping strokes were caught. *Procladius sagittalis*, *Cricotopus ornatus*, *C. bicinctus*, *Clunio marinus*, *Chironomus plumosus* and *Cladotanytarsus mancus* occurred in large numbers.

On the supralittoral *Fucellia tergina* was the dominant species. Numerous in this zone were: *Themira putris*, *Leptocera humida*, *Scatella subguttata* and *S. paludum*. The marine midge *Telmatogeton remanei* occurred on the stones of the supralittoral which are splashed by water in Gdynia. Besides these species, the supralittoral was inhabited by: *Swammerdamella brevicornis*, *Hilara chorica*, *Dolichopus nubilus*, *D. plumipes*, *D. unguatus*, *Hydrophorus praecox*, *H. litoreus*, *Sepsis cynipsea*, *Piophilula vulgaris*, *Copromyza atra*, *Leptocera fuscipennis*, *L. limosa*, *L. modesta*, *L. lutosa*, *Copromyza ragans*, *Thoracochoeta zosterae*, *Sphaerocera curvipes*, *Parydra cognata*, *P. pusilla*, *Scatella stagnalis*, *Scaptomysza pallida*, *Scatophaga suilla*, *Fucellia griseola*, *Myopina myopina* and *Lispe hydromyzina*.

In the epilittoral only several species inhabiting this marine zone were recorded, i.e., *Ephydra riparia*, *Rhicroessa nigripes*, *Hydrophorus praecox*, *Tachydromia sabulosa*, *T. terricola* and *Spilogona scutulata*. The sandy-coloured marine *Fucellia griseola* is associated with the epilittoral zone as opposed to the dark *Fucellia tergina* which inhabits the flooded-out supralittoral zone.

Others species listed in table 2, except for *Chironomidae*, were found accidentally in the Baltic marine habitats.

Flies and halophytes

In the saline areas some halophytes were inhabited by the gall-making or mining fly larvae and their flowers were visited by imagines.

Aster tripolium. — On this obligatory halophyte mining larvae of

Phytomyza asteris and *Liriomyza fasciola* (*Agromyzidae*), gall-making *Paroxyna plantaginis* and *Trupaena stellata* (*Tephritidae*) and phytomycetophagous *Clinodiplosis cilicrus* (*Cecidomyiidae*) were found. Larvae of *Phytomyza asteris* were found in leaves during two periods: in May and June, and September and October; the average number of larvae per leaf was four and the maximum was ten. The inflorescences of this halophyte were visited by: *Rhegmoclema verralli* (*Scatopsidae*), *Dilophus febrilis* (*Bibionidae*), *Eristalis arbustorum*, *E. tenax*, *Eristalinus sepulchralis*, *Helophilus hybridus*, *H. pendulus*, *Lathrophthalmus aeneus*, *Sphaerophoria scripta*, *Syrirta pipiens*, *Syrphus corollae* (*Syrphidae*), *Pelomyia coronata* (*Tethinidae*), *Madiza glabra* (*Milichiidae*), *Orthellia caesarion*, *Stomoxys calcitrans* (*Muscidae*), *Lucilia sericata*, *L. silvarum*, *Bellardia agilis* (*Calliphoridae*), *Eriotrix rufomaculatus* and *Dinera griseascens* (*Tachinidae*).

Spergularia salina. — Only *Syrphidae* were found on the flowers of this obligatory halophyte: *Eumerus strigatus*, *Lathrophthalmus aeneus*, *Sphaerophoria scripta*, *S. rueppelli*, *Liogaster metallina* and *Syrphus corollae*.

Triglochin maritimum. — On this halophyte only mining larvae of *Liriomyza angulicornis* (*Agromyzidae*) and phytomycetophagous larvae of *Coquillettomyia caricis* (*Cecidomyiidae*) occurred.

Atriplex hastatum var. *salinum*. — On this halophilic variety the mining larvae of *Pegomyia hyoscyami* (*Anthomyiidae*) were often present.

Sonchus arvensis var. *laevipes*. — Large numbers of *Cystiphora sonchi* galls (*Cecidomyiidae*) were found on the leaves of this halophilous variety; and *Eumerus strigatus* (*Syrphidae*) was present on the inflorescences.

COMMENTS ON SOME SPECIES

Ceratopogonidae

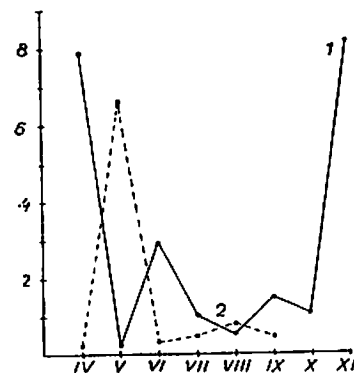
Culicoides longicollis GLUKHOVA, 1971

Found only in strongly saline inland areas of the Kujawy: Ciechocinek, Inowroclaw-Mątwy and Janikowo. The numbers of larvae on the bottom and in the filamentous green algae of the reservoirs were high, up to 80,625 per 1 m² in Ciechocinek (April 1975). The seasonal dynamics of larvae and imagines in Inowroclaw-Mątwy during 1975 are presented on fig. 11.

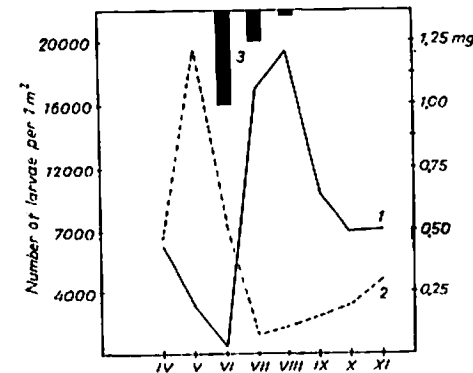
The species was only recently separated from *C. nubeculosus* and exact biological data are mostly lacking, but nevertheless it is considered here as a halobiont. The type specimens were collected in strongly wasted stream at Truskavets, Ukrainian Carpathians (GLUKHOVA, 1971), which

must also be saline because mineral springs and a health resort are nearby (ZAVŘEL, 1946; ZAVŘEL and PAX, 1951) and adults were recorded from regions where saline habitats are common. Many of the reports on *C. nubeculosus* inhabiting strongly mineralized waters must actually refer to *C. longicollis* (e.g., DŽAFAROV, 1964).

Geographic distribution: southern Ukraine, Transcaucasia, Kazakh, Turkmen and Kirghiz SSR (GLUKHOVA, 1979). Recorded from Poland for the first time.



11. Seasonal dynamics of *Culicoides longicollis* (*Ceratopogonidae*) in Inowroclaw-Mątwy during 1975. 1 — larvae (in thousands per 1 m² of the reservoir bottom), 2 — imagines (number per 10 strokes of an entomological net)



12. Seasonal dynamics of *Nemotelus* (*Stratiomyidae*) in *Salicornietum patulae* community in Inowroclaw-Mątwy during 1975. 1 — larvae number dynamics, 2 — dynamics of the average weight of one larva, 3 — dynamics of *Nemotelus notatus* adults

Stratiomyidae

Nemotelus GEOFFR.

Up to now data on the ecology of *Nemotelus* larvae were uncertain (ILLIES, 1978). Some authors stated that they are aquatic (NARČUK, in ŠTAKELBERG and NARČUK, 1969–1970). During this study larvae of *Nemotelus* (mainly of the halobiontic *N. notatus*) were found in numbers, up to 19,534 (fig. 12) per 1 m² of salt soils in the *Salicornietum patulae* community in Inowroclaw-Mątwy, mainly in a thick layer of green algae. From March to November 1975 the average numbers of larvae per 1 m² of this saline area sampled were as follows:

soil in <i>Salicornietum patulae</i> community	— 8,710
green algae patches on the salt water surface	— 556
bottom of saline pools	— 102