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The Specific Distinction of *Chrysozona pluvialis* (L.) and *Ch. hispanica* (SZIL.) (Diptera, Tabanidae) in Poland

Odrębność gatunkowa *Chrysozona pluvialis* (L.) i *Ch. hispanica* (SZIL.) (Diptera, Tabanidae) w Polsce

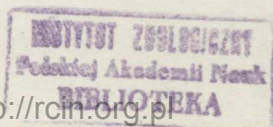
Обособленность видов *Chrysozona pluvialis* (L.) и *Ch. hispanica* (SZIL.) (Diptera, Tabanidae) в Польше

(With 2 figures and 1 table)

In the present paper an attempt is being made to establish whether the forms known as *Chrysozona pluvialis* (L.) and *Ch. hispanica* (SZIL.) constitute, on the ground of ecophysiological studies, separate and distinct species.

A detailed morphological study of the Polish species of *Chrysozona* MEIG. (MIKOŁAJCZYK, 1963), has shown that the differences between both species are inconspicuous, and even the structures of the postabdomen of males and females do not enable their identification. There are many specimens with intermediate characters, and it is not possible to include them, on the basis of morphology alone, to either of mentioned forms.

In the eastern Europe (OLSUFIEV, 1937) *Ch. pluvialis* (L.) and *Ch. hispanica* (SZIL.) are well defined forms both morphologically and geographically, and their specific rank is beyond doubt. In central Europe the main difference between these two forms is the colour shade of the underside of abdomen, which in *Ch. hispanica* (SZIL.) is blue-greyish and olive-brown in *Ch. pluvialis* (L.) The further to the west, the more inconspicuous the differences become between the said forms. In an elaboration of the German and Palearctic species (KRÖBER, 1925, 1932, 1938) as well as Belgian ones (LECLERCQ, 1957) these species are treated as forms, subspecies or varieties. In the study of *Tabanidae* of France (SÉGUY, 1926) both forms are included into *Ch. pluvialis* (L.). In central Europe they are usually regarded upon as species (MOUCHA, 1956;



TROJAN, 1959; MIKOŁAJCZYK, 1963), their specific rank, however, has not been sufficiently proved. In certain habitats, where both species occur, the identification of the specimens captured meets certain difficulties. Such places are to be found in the Kampinos Forest near Warszawa where the studies have been carried out.

The starting point for the present studies were the ecological differences found between the closely related species (DIVER, 1941) as well as the study on the species of the genus *Tabanus* L. (TROJAN, 1962); these investigations have shown that the closely allied species occupy different ecological niches.

The value of the morphological hiatus, which must be known before the specific separateness of species can be established, is not defined by any existing theory of taxonomy. When small morphological differences are found between the two forms, it is often impossible to decide whether the observed feature is of specific or interspecific rank. The existing difficulties arise because the morphological criteria are the only way to separate systematic units which are biologically different. The species recognized by the taxonomists, thus should possess apart from the common structural properties of their individuals, also certain similarities in other respects. In many cases, the biological characters of a species corroborate its morphological features, and in others the ecological or even physiological studies allow for separating the species which seem to be morphologically uniform. Such species known as ecospecies, biological species or sibling species, however, do not constitute any distinct and separate category of a biological unit, as suggested by CAIN (1954), since no evidences have been yet presented supporting this view.

The material was collected in the years 1955–1959 in the Kampinos Forest near Warszawa and the laboratory investigations were carried out at the Field Station of the Ecological Institute of the Polish Academy of Sciences at Dziekanów Leśny.

Results

Survival. The research on the longevity of individuals under the various thermic conditions was carried out in a laboratory, under the controlled conditions. The same artificial light has been applied in all temperatures. Constant relative humidity of the air was obtained by means of evaporating solutions; during the experiments the value of its humidity oscillated slightly between 70 and 80%.

Captured specimens were transferred to the laboratory as soon as they were collected, put on a wet cotton to drink, weighed on the torsion scales, and placed in the jars covered with gauze, 10 specimens in each, which were then put into thermostates. During the whole experiment the longevity of each specimen watched through the glass has been recorded.

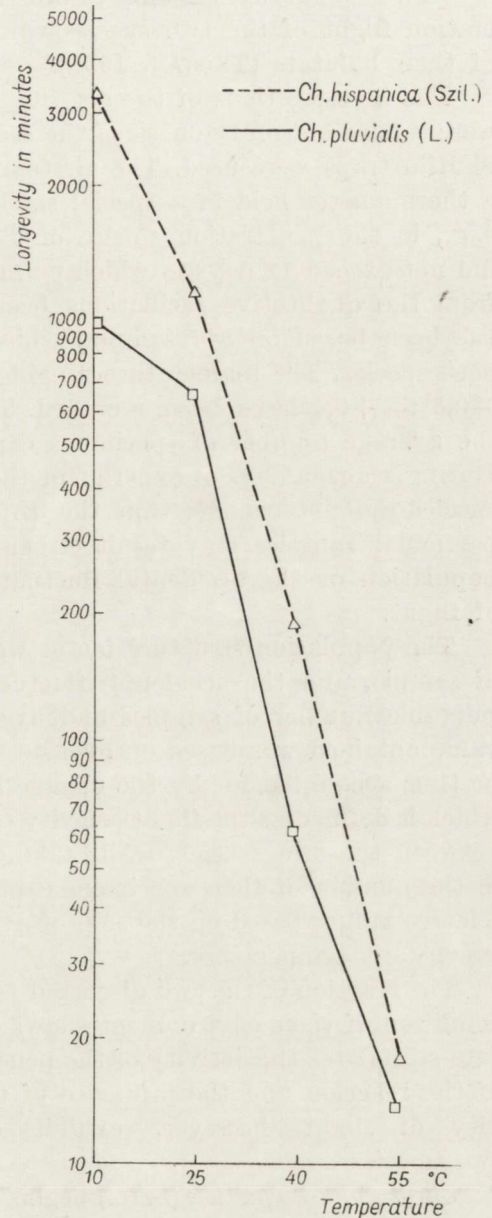
The specimens inside the jars were either immobile seen on their bottom and walls, or were seen creeping on them. Short before their death the spe-

cimens turned upside down and ceased to move their legs. This leg movement, after being carefully checked, has been regarded as the definite death of each specimen involved. After experiment the dead specimen have been weighed again on the torsion scales.

The results obtained (fig. 1) indicate both the similarity and the differences in the reactions of specimens of both species. The highest survival of both species of *Chrysozona* MEIG. occurs in the low temperatures ($+10^{\circ}\text{C}$). With the temperature of environment rising the survival capacities on the species drop. Considerable differences have been also noted in the time of survival of the species. In the temperature of $+10^{\circ}\text{C}$ *Ch. pluviialis* (L.) dies three times quicker than *Ch. hispanica* (SZIL). With the temperature rising the difference in the resistance properties between two species diminishes, but is always distinct.

The loss of water by the organism, which occurs particularly fast in the higher temperatures, should be probably looked upon as the cause of death. The weight of the dead specimens was 7,5–9,5% lower than that of alive ones weighed before the experiment. In the high temperatures ($+55^{\circ}\text{C}$) the specimens of both species did not live more than 20 minutes. The almost 10% loss of body weight in so short lasting experiments should be undoubtedly attributed to the loss of water by the organism involved.

Fig. 1. Survival of *Chrysozona* MEIG. under various thermic conditions, without access to the water.



Of the two examined species, *Ch. hispanica* (SZIL.) is more resistant to the high temperatures and it better preserves its water supplies. These observations may be corroborated by the distribution data of this species which occurs

mainly in the steppe-zone of the USSR, while *Ch. pluvialis* (L.) is distributed north of that area. Thus the first of the mentioned species seems to be more endangered by the loss of water than the second one.

The activity of the penetration flight. The activity of the penetration flight of the two species varies depending on the thermal conditions of their habitats (TROJAN, 1958).

The investigations of the activity in flight under the various temperatures were carried out on the basis of the series of 10 minutes collecting samples while Skuffin traps were used. The air temperature was measured by the means of a thermometer held in a special shield and suspended 2 m above the ground, e. g., in the penetration sphere of *Tabanidae* (TROJAN, 1958). Collecting time did not exceed 12 days — which permitted to obtain the results independently from the qualitative oscillations occurring during a season. The measuring has been based on 567 samples which supplied 3001 specimens belonging to both species. The temperature ranging was 1°C, whereas the limit values from -0,5 to +0,4 have been recorded. The activity of flight was determined by the average number of specimens captured during a constant period of time. During a dozen days of experiment the number of specimens belonging to both species did not change, thus the differences in the qualitative values of the particular samples may result either from: the aggregative structure of the population or the accidental fluctuations and or the change in the activity of flight.

The population structure factor was eliminated by the 10 minute duration of sample, and the accidental fluctuation factor was eliminated by the considerable number of samples and by the average values used; every average value obtained was based on over 40 samples. The differences established may be thus accounted for by the change in the intensity of the penetration flight which is defined as the flight activity (HADDOV and others, 1950). A comparison between the two species, while taking into account a considerable difference in the number of their specimens captured, has been carried out by using the relative values based on the sum of average values (peculiar for a given species at a constant temperature).

The reaction of the two discussed species of *Chrysozona* MEIG. to the thermal condition of their environment shows certain similarities. The rise in temperature stimulates the activity of the penetration flight in both species. The course of the reaction and the influence of the particular temperatures on the activity of flight, however, exhibit considerable differences between the two species.

Chrysozona hispanica (SZIL.) begins its penetration flight in the air temperature 16°C. Up to 19°C the activity of flight of this species rises very intensively. Further increase in the temperature does not influence any more the agility of the specimens. Even the 10°C temperature rise (up to 29°C) brings about a bare 7% rise in the flight activity. In this species only one critical

drastic change of the flight activity occurs between 16 and 19°C (see the table below).

The relation of the activity of the penetration flight to the air temperature in *Ch. pluvialis* (L.) presents a different picture. The beginning of the penetration flight in this species occurs only in the temperature 17°C.

Flight activity of *Chrysozona pluvialis* (L.) and *Ch. hispanica* (SZIL.)

	Air temperatures in °C													
	16	17	18	19	20	21	22	23	24	25	26	27	28	29
<i>Chrysozona pluvialis</i> (L.)														
N	0.00	0.49	0.63	0.71	0.71	0.71	0.85	0.99	1.41	2.31	3.29	4.48	6.37	7.05
A	0.00	1.63	2.10	2.37	2.37	2.37	2.83	3.30	4.70	7.70	10.97	14.97	21.23	23.50
<i>Chrysozona hispanica</i> (SZIL.)														
N	0.08	0.22	0.25	0.28	0.29	0.29	0.30	0.30	0.31	0.31	0.31	0.31	0.31	0.31
A	2.07	5.69	6.46	7.24	7.49	7.49	7.75	7.75	8.01	8.01	8.01	8.01	8.01	8.01

N — average number of specimens captured during 10 minute collecting sample

A — activity of penetration flight (% of specimens number, captured at a given temperature)

Despite the fact that the number of specimens collected of *Ch. pluvialis* (L.) exceeds twice that of the preceding species, its flight activity is three and half times smaller than that of *Ch. hispanica* (SZIL.). The increase in the flight activity in *Ch. pluvialis* (L.) takes place in the temperatures 17–18°C, further increase in the temperature up to 21°C does not cause a corresponding increase in the activity of flight. In these conditions, when *Ch. hispanica* (SZIL.) reaches its peak ability in flight, *Ch. pluvialis* (L.) is still three times less active than the preceding species.

The situation changes only when the temperature of air increases above 22°C. The activity of *Ch. pluvialis* (L.) in this moment abruptly increases and between 25°C and 26°C reaches the flight activity similar to that of *Ch. hispanica* (SZIL.). A further increase of temperature induces a further increase in the flight activity. In temperatures above 25°C more than 70% of the active flight of this species is performed, while in the related species *Ch. hispanica* (SZIL.) in the same range of temperatures (26–29°C) the flight activity is only 32%. The selective influence of the different thermal conditions on the flight activity of the species is thus very conspicuous. In periods with air temperature 15–25°C *Ch. hispanica* (SZIL.) is definitely more active species than *Ch. pluvialis* (L.). In temperatures 26–29°C the reverse is the case.

The experiments have been repeated during three consecutive years. The data obtained showed great similarity with those obtained earlier, particularly with regard the the critical values.

The dynamics of numbers. The data have been obtained with the help of Skuffin trap kept in a permanent place. Each sample was carried out at noon in sunny weather during one-hour collecting spell. Such samples have taken place once in a week from spring until autumn.

The allied sympatric species of *Tabanidae* (TROJAN, 1958) inhabiting similar ecological niches usually do not occur in the same time. Of a particularly great importance is the difference in the beginning of flight, when a nuptial flight of a species is performed. For, if two allied species are not separated by distinct genetic barriers, their existence (when they occur together) is only possible when either their nuptial flight do not coincide or they require different breeding conditions. As far as *Ch. pluvialis* (L.) and *Ch. hispanica* (SZIL.) are concerned, the genetic barriers between these two species have not been studied as yet. A great number of intermediate forms found in the area of Kampinos Forest, may indicate that such barriers do not exist and a crossing between the species mentioned takes place. *Ch. pluvialis* (L.) does not occur in the nuptial period of *Ch. hispanica* (SZIL.) as it does not appear until the third decade of June, and, moreover, in small numbers. When *Ch. hispanica* (SZIL.) disappears a mass-flight of *Ch. pluvialis* (L.) begins. Although the former species may still occur in the Kampinos Forest until the middle of August, it is then very rare and at most odd specimens may be collected. A main factor which keep apart the two species is thus the period of their occurrence.

Distribution in biotops. To study the biotope distribution, a "section" method has been applied. This method consists of carrying a Skuffin trap over

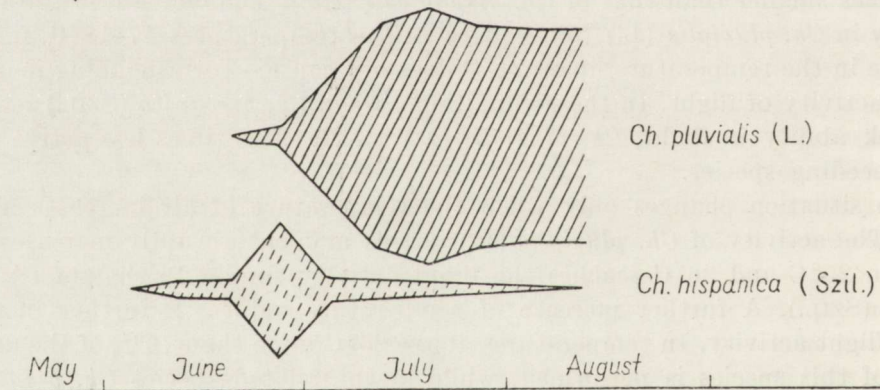


Fig. 2. Seasonal dynamics of *Chrysozona* MEIG. in the Kampinos Forest observed during the summer 1955; 1 mm of width corresponds to 1 specimen captured during one hour.

the chosen routes and capturing all specimens attacking the trap at ten-step distances. The qualitative results thus obtained were analyzed on the basis of a map of the area involved. Certain differences have been observed in the occurrence of the two species in particular biotopes of Kampinos Forest. *Ch. hispanica* (SZIL.) appears in June—which is the period of the greatest abun-

dance of this species, over the whole area of Kampinos Forest, where distribution of this species is determined by the availability of food and water (TROJAN, 1958).

The species is encountered in the various types of pine forest, alder forest and on meadows. In July, when the second species — *Ch. pluvialis* (L.) abundantly appears, *Ch. hispanica* (SZIL.) shows a sudden decline in number, the odd specimens of this species being found along edges of woods and meadows. The remaining forest areas is populated exclusively by *Ch. pluvialis* (L.) which abundantly occurs on the meadow as well.

The differences in behaviour. In the European species of *Tabanidae* no selectivity of food has been discovered. All the blood-sucking species attack willingly large mammals. It is well known, however, that certain large species (*Tabanus bovinus* L.-group) rarely attack humans but most frequently horses and cattle. The majority of the remaining species feed equally readily on the large ungulated mammals as on humans. It has been stated, however, (TERTERIAN, 1954), that different species choose different places on their hosts. As far as *Ch. pluvialis* (L.) and *Ch. hispanica* (SZIL.) are concerned the artificial baits were used, thus on information could have been obtained with respect to the feeding site on a natural host. Both species attacked the sides of trap as well as their bottom. During collecting at sides of the trap differences have been noticed in the reaction of specimens to the movement of the entomological net and the approaching of humans. While *Ch. hispanica* (SZIL.) allows an approach of 2–3 steps and afterward flies over to the other side of the trap, *Ch. pluvialis* does not fly off having seen the collector, and when scared by strokes of the net it often promptly returns to rest at a nearby place.

Discussion

The ecological and physiological data presented in the paper allow us to assume that in the solution of systematic problems morphological as well as ecological and physiological methods can be equally applied. In the case when morphological criteria do not suffice for establishing a specific rank of a given population, the studies carried out in the field (on a living material) may reveal the biological distinctness of this population.

As far as *Ch. pluvialis* (L.) and *Ch. hispanica* (SZIL.), a pair of sympatric species in central Europe, are concerned, it has been stated that:

1. *Ch. hispanica* (SZIL.) possesses greater resistance to various thermal conditions of its environment than *Ch. pluvialis* (L.). The better survival of *Ch. hispanica* (SZIL.) can be explained by the fact that the specimens of this species can better preserve water in their organism than those of another species.

2. The activity of flight of *Ch. hispanica* (SZIL.) shows only one critical point, and in air with the temperature above 20°C it remains steady up to 29°C,

while in *Ch. pluvialis* (L.) two critical points in the activity curve have been observed — one between 17 and 18°C when a moderate activity begins, and the other above 22°C when the activity of flight rises abruptly.

3. The time of occurrence of the two species is not identical. While *Ch. hispanica* (SZIL.) appears in the spring, *Ch. pluvialis* (L.) emerges at the end of a mass flight period of this species and reaches a peak abundance at a time when only single, odd specimens of *Ch. hispanica* (SZIL.) may be encountered.

4. *Ch. pluvialis* (L.) can be found in all sorts of habitat throughout its occurrence period whereas *Ch. hispanica* (SZIL.) gradually disappears from its habitats to be found finally only in an intermediate zone at the edge of woods and meadows.

5. *Ch. hispanica* (SZIL.) is shier, and can be frightened off more easily than *Ch. pluvialis* (L.)

The data presented may also be interpreted in the light of certain concepts concerning the origin of both species. *Ch. hispanica* (SZIL.) is a steppe-bound species occurring in the southern part of Europe. The penetration of this species into the central Europe was probably due to the deforestation and the steppe-transformation process on large, original forest areas which were gradually brought under cultivation. *Ch. pluvialis* (L.) is a forest species, commonly occurring in central Europe and in the forest areas of its eastern part. Both species show biological characters common to the whole family of *Tabanidae*, being water-dependent insects frequently drinking to renew their water-supply. The steppe areas are, of course, drier than the forests and provide less drinking sites. Thus a better ability to preserve the water in *Ch. hispanica* (SZIL.) than in *Ch. pluvialis* (L.) may be easily explained. This adaptation persists still despite the fact that the species changed its original habitats.

Ch. hispanica (SZIL.) is, moreover, an early-spring species, displaying its full activity even at the average temperature. By contrast, *Ch. pluvialis* (L.) is a summer species, which does not become fully active until the warm, summer period. The differences in the adaptation of the two species to various thermal conditions may be accounted for by a different origin of these species. The data mentioned above, indicate, in our opinion a specific distinctness of the species discussed in the central Europe, despite only slight morphological differences which has been observed among them.

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STRESZCZENIE

Autorzy zbadali dwa gatunki bliźniacze *Chrysozona pluvialis* (L.) i *Ch. hispanica* (SZIL.) różniące się zabarwieniem spodniej strony odwłoka, dla ustalenia różnic biologicznych. Okazało się, że *Ch. hispanica* (SZIL.) jest gatunkiem lepiej chroniącym zapasy wody w organizmie niż *Ch. pluvialis* (L.) i dzięki temu jest bardziej wytrzymała na działanie temperatur dodatnich.

Aktywność lotu penetracyjnego *Ch. hispanica* (SZIL.) wzrasta najsilniej w przedziale temperatur 16–19°C, dalej utrzymuje się na tym samym poziomie. U *Ch. pluvialis* (L.) stwierdzono dwa progi aktywności, pierwszy (17–18°C) wyzwalający aktywność umiarkowaną, drugi (22°C), powyżej którego aktywność lotu tego gatunku wzrasta gwałtownie.

Dynamika liczebności gatunków nie pokrywa się całkowicie w czasie, nie zachodzą na siebie okresy rozrodcze.

Ch. pluvialis (L.) przez cały okres występowania zajmuje na terenie Puszczy Kampinoskiej wszystkie środowiska, *Ch. hispanica* (SZIL.) pod koniec okresu występowania zajmuje środowiska przejściowe między lasem a łąkami.

Ch. hispanica (SZIL.) jest gatunkiem bardziej płochliwym niż *Ch. pluvialis* (L.).

Różnice dotyczące adaptacji ekofizjologicznych dają się interpretować w świetle danych o pochodzeniu obu gatunków. *Ch. hispanica* (SZIL.) — gatunek stepowy, prawdopodobnie wtórny mieszkaniec środkowej Europy, jest przystosowany do życia w warunkach wiosennych, przy słabej dostępności wody do picia; *Ch. pluvialis* (L.) — gatunek leśny, przystosowany do warunków letnich i środowisk bogatych w mikroziorniki wodne.

Duże różnice biologiczne zaobserwowane między oboma gatunkami pozwoliły na stwierdzenie ich odrębności, mimo małych różnic morfologicznych.

РЕЗЮМЕ

Авторы исследовали два очень близкие вида: *Chrysozona pluvialis* (L.) и *Ch. hispanica* (SZIL.) отличающиеся окраской нижней стороны брюшка, для установления биологических различий. Оказалось что *Ch. hispanica* (SZIL.) является видом лучше сохраняющим воду в организме чем *Ch. pluvialis* (L.) и благодаря тому является видом более теплоустойчивым.

Активность поискового лёта *Ch. hispanica* (SZIL.) усиленно возрастает в пределе температур 16–19 °C, дальше держится на том самом уровне. У *Ch. pluvialis* (L.) констатировано два предела активности, первый (17–18 °C), вызывающий умеренную активность, второй (22 °C), выше которого активность лёта этого вида резко возрастает.

Динамика количественности видов не покрывается совсем во времени, периоды размножения не совпадают с собой.

Ch. pluvialis (L.) через весь период встречаемости является в Кампиносской пуши во всех средах, *Ch. hispanica* (SZIL.) при конце периода встречаемости занимает места переходные между лесом, а лугами.

Ch. hispanica (SZIL.) является видом более пугливым, чем *Ch. pluvialis* (L.).

Различия в экофизиологических адаптациях можно выяснить на основании о происхождении обоих видов: *Ch. hispanica* (SZIL.) — степовой вид — по всей вероятности вторичный жилец центральной Европы, является приспособленным к жизни в весенних условиях и при слабой возможности добычи воды для питья; *Ch. pluvialis* (L.) — лесной вид — приспособленный к летним условиям и к средам богатым с малыми водоемами.

Большие биологические разницы наблюдаемые между обоими видами позволили констатировать их обособленности помимо малых морфологических различий.

Redaktor pracy — prof. dr J. Nast