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Male genitalia and sexual index in *Trichogramma cephalciae* (Hymenoptera, Trichogrammatidae)

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Abstract. The male genitalia of *Trichogramma cephalciae* Hochmut & Martinek are described and supplemented by photographs from light and scanning electron microscope. Samples of *Trichogramma* from several years and localities in Bohemia and Polish Beskydes from eggs of *Cephalcia* sp., *C. abietis, C. arvensis, C. erythrogaster* and *C. fallenii* were examined. The aim of this contribution is to supplement the character of *T. cephalciae* by the analysis of basic structures of the male genitalia, because in the original description from 1963 these were not discussed. The sex ratio of parasitoid was investigated in adults emerged from individually field-collected eggs of *C. abietis*. Males represented 24.7. %. From one host egg, adults of both sexes (in 84.3 %) as well as adults of only males (in 6.9 %) or femalles (in 8.8 %) emerged.

There are few records of the egg parasitism of *Cephalcia* species by *Trichogramma* spp. Probably the first mention of the parasitism of *Cephalcia abietis* (Linné) (=*Lyda hypotrophica* Hartig) by *Trichogramma* in Germany dates from Baer (1903 cited in Kudela, 1957). Parasitism of *C. arvensis* Panzer, by *Trichogramma evanescens* Westwood, was reported by Boas (1933) in Denmark. In Bohemia parasitism of *C. abietis* by *Trichogramma* was first mentioned in late 50's (Kudela, 1957; Kolubajiv, 1959). Kolubajiv (1959) identified parasitoid reared from eggs of *C. abietis* as *T. pini* Mejer but failed to rear the parasitoid in *Sitotroga cerealella* (Olivier), *Leucoma salicis* (Linné) and *Tortrix viridana* Linné. He reported that *Trichogramma* emerged from a part of parasitized eggs only next spring as a consequence of larval diapause.

These data on the bionomy of *Trichogramma* originating from parasitized eggs of *C. abietis* from localities of the Krušné hory (Ore Mountains), i.e. no acceptance of alternative host and larval diapause in a part of the population, are identical with bionomy of *Trichogramma cephalciae*, egg parasitoid of *C. abietis*, described by Hochmut & Martinek in 1963 also from the Krušné hory mountains.

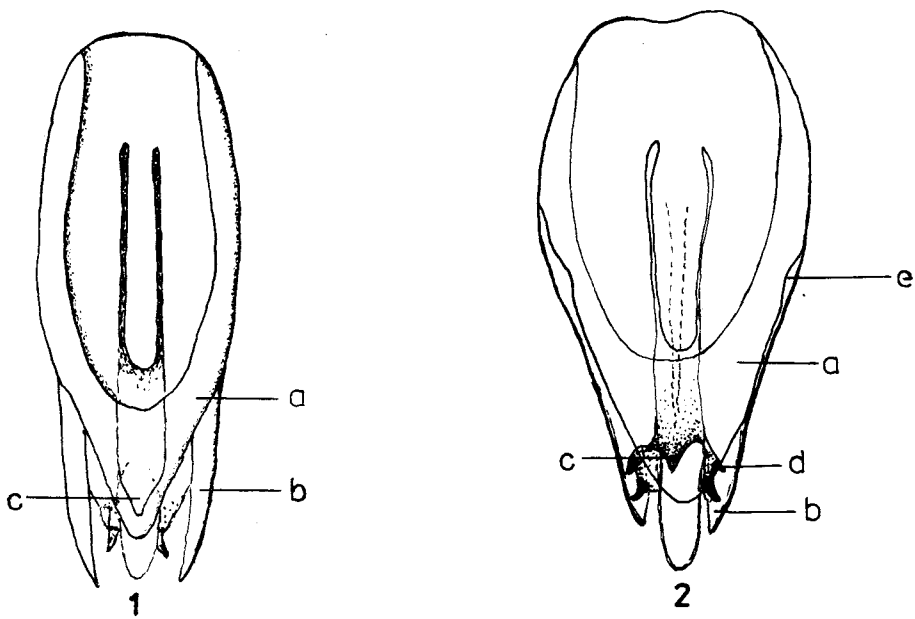
Differential characteristics mentioned by Hochmut & Martinek (1963) were

Plate I, II will be found at the end of this issue

mainly concerned with ovipositor length, colour of adults and the shape of the last antennal segment of the male. Unfortunately, these authors did not describe male genitalia, as this feature was not used in species diagnoses at that time.

Viggiani (1971) first described the male genitalia of *T. cephalciae,* schematically, and without indicating the host species (Fig. 1). Dyurich (1980) published the description of male genitalia of a *Trichogramma* reared from eggs of *Acantholyda nemoralis* (Thomson) on pine and identified it as *T. cephalciae* Hochm. & Mart. (Fig. 2). Walter (1982) reported *T. cephalciae* as an egg parasitoid of *Cephalcia* spp. For the first time it was recorded in Germany in 1981 in the "Erzgebirge", i.e. the same mountains as "Krušné hory", from where the type material of *T. cephalciae* Hochm. & Mart. originated. In another paper (Walter, 1986) presented data on the bionomy of this species, which are identical with known data (no acceptance of the other hosts and occurrence of larval diapause in a part of the population).

As the description of male genitalia of Bohemian population of *T. cephalciae* has not been published it is presented here and comparison is made between photographic material from light and scanning electron microscopes.



Figs 1–2: Male genitalia of *Trichogramma cephalciae*. 1 – From Viggiani (1971); 2 – from Dyurich (1980); a – dorsal expansion of phallobase; b – paramere; c – ventral expansion of phallobase; d – digital sclerites; e – slight constriction of phallobase.

MATERIAL AND METHODS

Material examined. Bohemia: Krušné hory, Jiřího návrší, *C. abietis,* 1965; Českomoravská vrchovina, Český Rudolec, *C. abitetis,* 1977; Šumava, Železná Ruda, *C. abietis* 1982, 1987; Krušné hory, Nejdek, *C. abietis,* 1987; Šumava, Nýrsko, *C. abietis* , Krkonoše, Harrachov, *C. abietis* 1987; Krkonoše, Benecko, *C. abietis,* 1987; Orlické hory, Náchod, *C. arvensis,* 1988.

Poland: Bielsko-Biała, Bystra, *C. erythrogaster* (Hartig), 1982; Bielsko-Biała, Salmopol, *C. fallenii* (Dalman), 1982; Wisła, Olza, *C. abietis,* 1982; Ustroň, Holcyna, *C. abietis,* 1982, 1986; Węgierska Górka, Skrzyczne, *C. erythrogaster,* 1982; Gorczanski Park Narodowy, *Cephalcia* sp., 1982; Węgierska Górka, Skrzyczne, *Cephalcia* sp., 1983; Bielsko-Biała, Bystra, *Cephalcia* sp., 1983; Bielsko-Biała, Skalite, *Cephalcia* sp., 1983; Bystrzyca Klódska, Spalona Góra, *Cephalcia* sp., 1983; Lądek Zdrój, *C. fallenii,* 1984; Wisła, *C. abietis,* 1985; Zdroje Jarków, *C. arvensis,* 1987.

The parasitoids were killed in a 80 % alcohol and lihgtened in lactid acid. Whole bodies or their parts were mounted in Liquide de Swan medium. Photographs were made through light microscope. The wasps for examination and photographing in the SEM were freeze-dried and coated with gold. The photographs were made on SEM model Tesla BS 301.

Data on the number and sex of *T. cephalciae,* emerging from individual host eggs of *C. abietis,* were obtained by observing 102 eggs placed individually into glass tubes.

Teminology suggested by Nagarkatti & Nagaraja (1971), Sugonyaev & Sorokina (1975) and Pointel (1977) was used for description of some structures of the male genitalia.

Morphology of male genitalia of *T. cephalciae* Hochm. & Mart.

Among the most characteristic structures of male genitalia of *T. cephalciae,* visible in the light microscope, were:

– a conspicuous and relatively narrow median ventral ridge, posteriorly highly sclerotized and extending into an arrow-shaped median ventral projection (Plate I, Fig. 1);

– two chelate structures (digital sclerites according to Sugonyaev & Sorokina, 1975) are a specific feature, which are arch-like extended outwards below the sickle-shaped curved apices (Plate I, Fig. 2);

– apices of the chelate structures are covered by gonoforceps (paramere according to Sugonyaev & Sorokina, 1975), but their shape in the photo is clearly visible (Plate I, Fig. 2);

– dorsal expansion of phallobase more or less triangular with broadly rounted apex (Plate I, Fig. 3) but, depending up on the position in the slide, it can be slightly pointed (Plate I, fig. 4);

– at greater magnification, on both sides of the median ventral ridge and before the end of phallobase, "spots" are visible (plate I, Fig. 1) which are clearly visible as protuberances (Pointel, 1977) on photo from SEM (Plate II, Fig. 2);

The distal structures of male genitalia of Hymenoptera consist of movable lobes provided with muscles (Snodgrass, 1935). These may cause the appearance of distortion in distal structures of male genitalia mounted in total slides. However, the configuration of surface structures in the male genitalia is shown

accurately in SEM photographs. Since only the ventral aspect was photographed, the dorsal expansion of phallobase could not be seen. The following surface structures may be observed on Plate II, Figs 1, 2;

– median ventral ridge of identical width along the whole visible part of male genitalia from ventral side (Plate II, Fig. 1);

– at the end of phallobase, before and behind the concaves arcs, that gradually transform to chelate structures, two types of protuberances can be seen on both sides of the median ventral ridge:

(a) crater-shaped elevation with pole (sensillae) in the centre, ventrally, before the concaves arcs;

(b) warts in dorsal direction below both concaves arcs (Plate II, Fig. 2);

– chelate structures on both sides of the extension of the median ventral ridge. Inwardly, the chelate structures are formed by expansion of concave arcs in a wave-like postero-lateral direction. The apices are completely covered by gonoforceps. In their centre a nearly S-like ridge is visible, interrupted in the middle by an eliptical depression which is slightly elevated in the centre;

– laterally the phallobase expands by two longer extensions – gonoforceps and subapically sensillae are visible (Plate II, Fig. 1);

– aedeagus considerably extended beyond the apices of gonoforceps. In median line of aedeagus a ridge are visible. Subapically on both sides of the ridge sensillae are visible (Plate II, Fig. 1).

By comparison of the present material of *Trichogramma* with the slides of types of *T. cephalciae* Hochm. & Mart. (from the collection of the National Museum in Prague - Kunratice, [the type No. 25473, holotype ♀, allotype ♂ and other paratypes, locality Jiřího návrší, Krušné hory, Bohemia, leg. 5. vii. 1959 Martinek, *Trichogramma cephalciae* sp. n. det. Hochmut]), it is without doubt that the former belongs to a population of the same species.

Although Viggiani (1971) and Dyurich (1980) have published illustrations of male genitalia of *T. cephalciae*, as depicted in Figs 1 and 2, it is hoped that the present description of male genitalia of *Trichogramma*, from tha original host and based upon photographs from lihgt and scanning electron microscopy, will help and facilitate other workers to identify this species. This paper confirm the assumption of Wiąckowska (1987) about the probability of *T. cephalciae* occurrence in Poland.

Number and sexual index of *T. cephalciae* from one host egg

As mentioned above, so far it was not possible to rear T. cephalciae in alternative hosts (Kolubajiv, 1959; Walter, 1986), with exception of *Protoparce sexta* Joh. and *Sphix ligustri* L. (Bírová, 1971). For this reason, it was not possible to examine the sex ratio in the offspring of fertilized or unfertilized females with individual oviposition, since no suitable hosts were available. It

TABLE 1. Number and sex of *Trichogramma cephalciae* emerged from one host egg of *Cephalcia abietis*, locality Český Rudolec 1977

Frequency	Number of adults emergence/one host egg														
Treatment	4	5	6	7	8	9	10	11	12	13	14	16	*n*	*	% of males
Total	4	7	15	14	25	12	8	7	4	3	1	2	102	8.2	24.7
♂ in %	18.8	22.8	18.9	12.2	25.0	14.8	26.3	57.1	16.6	25.6	16.6	34.2			
Mixed sex	3	7	11	12	20	11	7	5	4	3	1	2	86	8.3	20.3
♂ in %	25.0	22.8	16.7	14.3	16.2	16.2	15.7	40.0	16.6	25.6	16.6	34.2			
Males only			1		3		1	2					7	8.9	100.0
Females only	1		3	2	2	1							9	6.8	0.0

* Av. No. of adults emerg. from 1 host egg

TABLE 2. Sex ratio of a part of *Trichogramma cephalciae* population from the examined collection, locality Český Rudolec, 1977

No. adults emerged from one host egg	Ratio ♂:♀	Frequency No.	%
4	1:3	23	75.0
5	1:4	6	85.7
6	1:5	9	81.8
7	1:6	9	58.3
8	1:7	16	80.0
9	1:8	8	66.7
10	1:9	4	50.0
11	1:10	0	0.0
12	1:11	1	25.0

was possible to examine the sex ratio of adults, emerged from individual field collected eggs of *C. abietis* only. Hochmut & Martinek (1963), Dyurich (1980) and Walter (1986) reported on the occurence of males in *T.cephalciae* population, but only Walter (1986) refered to sex ratio. In 1981 the sex ratio of males to females was 1:6.5 (13.3 % of males), in 1982 it was 1:5.5 (15.4 % males) and in 1983 it was 1:8.9 (10.1 % of males).

In both live adults, from parasitized eggs of *C. abietis* and *C. arvensis,* and the dried specimens, the proportion of males was relatively low (in various years). The number and sex of examined material of 102 *C. abities* eggs, originating from the locality of Český Rudolec, Českomoravská vrchovina mountains in 1977 is presented (Table 1).

From one host egg between 4 and 16 (av. 8.2 wasps emerged. The male percentage represented 24.7 % (1♂:3♀). From individual *C. abietis* eggs adults of mixed sex emerged (from 86 eggs, i.e., in 84.3 %) as well as adults of only males (from 7 eggs, i.e., in 6.9 %) and females (from 9 eggs, i.e., in 8.8 %). In the adults of mixed sex,, the males represented 20.3 % (av. 8.3 adults from one host egg). When only males emerged, the average number was 8.9 parasitiods, and when only females, the average was 6.8 parasitoids.

In most cases only one male emerged from one host egg regadless of how many parasitoids emeged (Table 2). In 50 % of cases, one male with 9 females emerged (compare with Table 1), in 85.7 % one male with four females, etc. In the group with more than 10 adults from one host egg, i.e., 11 to 16, only in one case (25 %) one male with 11 females emerged. In another cases between two and 10 males emerged from individual eggs.

Most *Trichogramma* species are arrhenothokous and both sexes are found. As a rule, progeny of a fertilized female consists of 2/3 female and 1/3 male (Quednau, 1960). In large eggs, as a consequence of favourable food conditions,

more females are found – as much as 80–90 %, e.g., *T. embryophagum* from eggs of *Dendrolimus* sp. or *Thaumatopeae* sp. (Quednau, 1960). Kadłubowski (1961) found 21 % males by *T. embryophagum* reared from *Acantholyda nemoralis*.

As the above results show, there is a wide range of male proportion in the population of *T. cephalciae*. However, the average occurence identified in a sufficiently large sample (837 adults of *T. cephalciae*) is decisive. The mean proportion of males in the examined population (24.7 %) corresponds with the occurrence of male in *T. evanescens*, e.g., by investigation of 1,073 specimens from *Ostrinia nubilalis* Hübner, males represented 24.4 %, and of 1,230 specimens from *Mamestra brassicae* L. there were 13.4 % of males (Bírová unpubl.).

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